MicroComputer JOURNAL

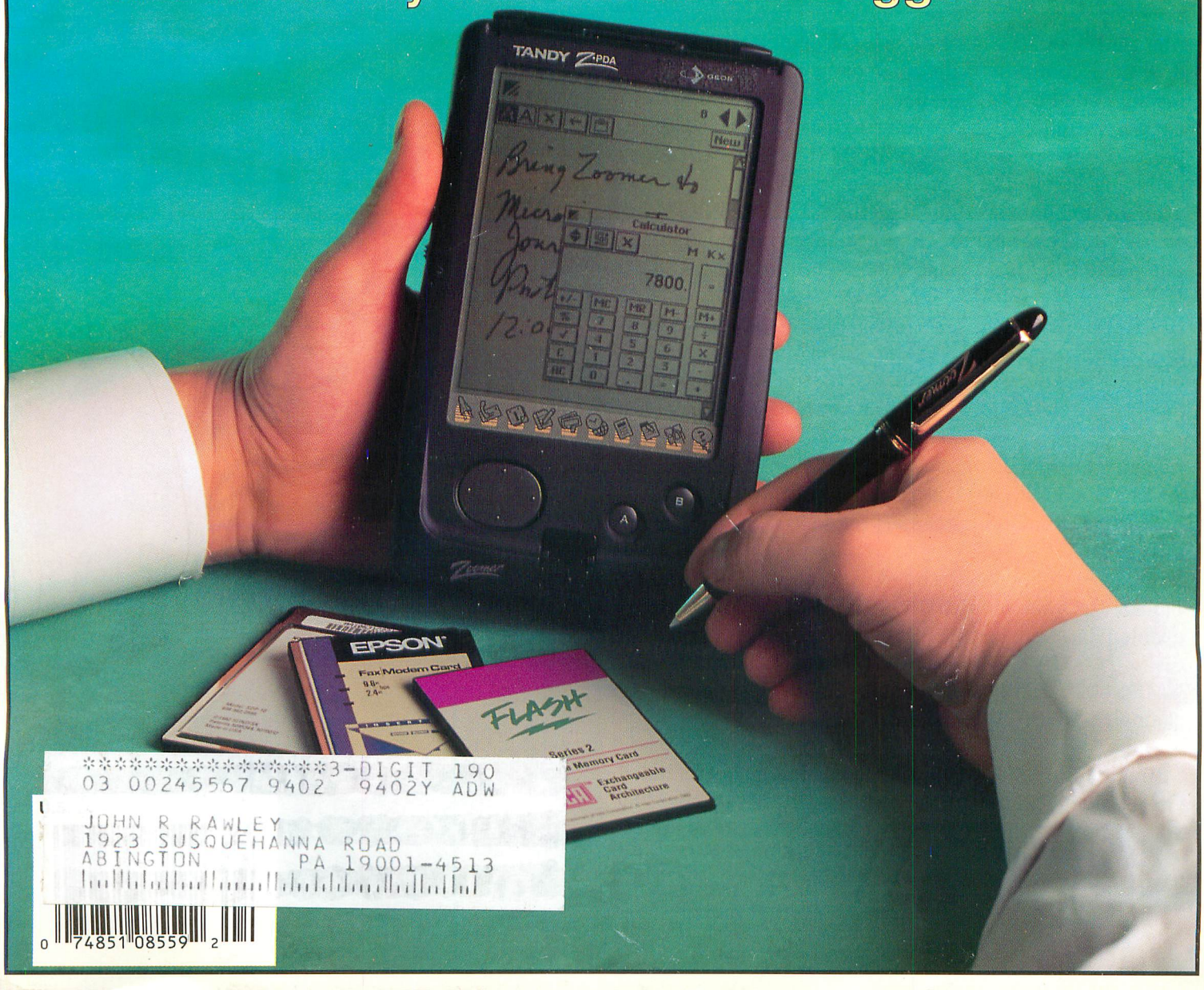
The print forum for the MicroComputer professional and semi-professional

Formerly ComputerCraft

March/April 1994

PCMCIA and PDAs: Two Hot New Technologies For The '90s

- The Real Cost Of Upgrading To *Windows* 3.1
- OS/2 2.1 And High-Speed Communications
- Build A Battery-Powered Data Logger



68HC11 Controller & Languages

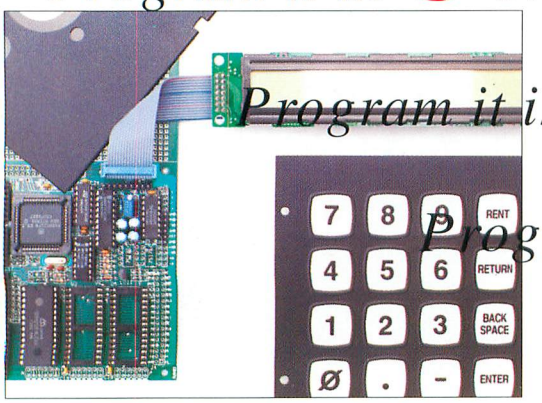
Program it in **C** *or*

Program it in **Basic** *or*

Program it in **FORTH** *or*

Program it in **Assembly**

$99



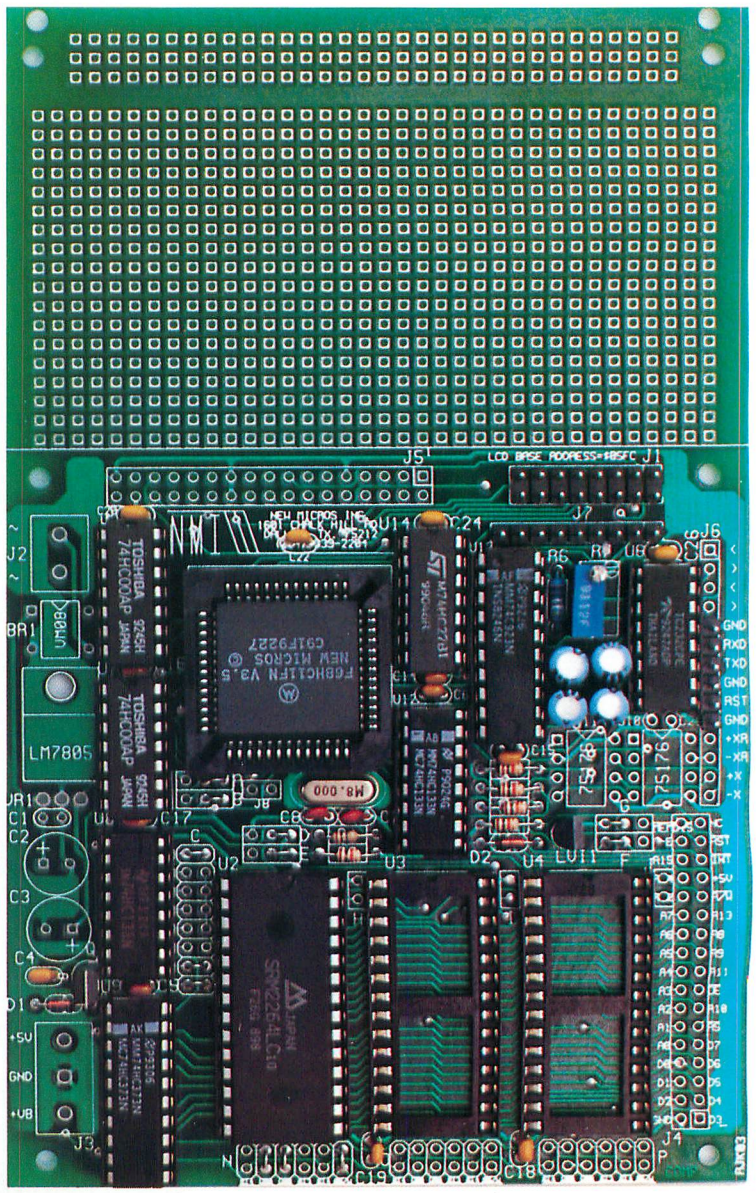
Low Cost Development Package: Controller + Languages + Manuals on disk included!

Package Price Breakthrough!

The NMIT-0020 Single Board Computer is perfect for dedicated controller with convenient interfaces for LCD displays and keypad. Intelligent LCD's up to 2 lines by 80 characters and matrix keypads up to 4x5 can be used. The processor is the popular F68HC11 with many features, including SCI and SPI serial channels, 8-bit 8-ch. A/D, 20 available I/O lines, Watch Dog Timer, 1/2K EEPROM and Max-FORTH w/Floating Point Package embedded in 12K internal ROM. SBC expands F68HC11 providing 3 28-pin JEDEC sockets for 8-32K RAMs, ROMs, EPROMs, EEPROMs, etc. RS-232 conversion supplied. Requires external regulated supply: 5V at ~30 mA. Based on NMIX-0020 board, so many features may be added as desired by the user (or by factory - call for details & prices).

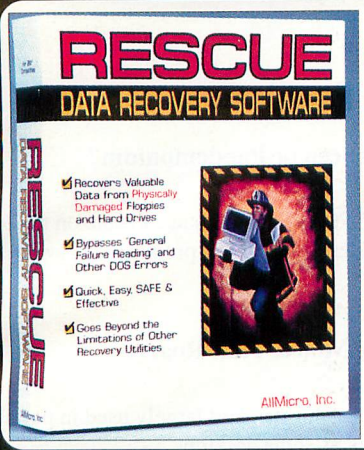
Languages supplied on accessory disk: Small C, Basic, and Assembler. FORTH resident on chip (may be disabled). Languages come with manuals on disk. Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. WIPE utility included allows internal ROM, EEPROM, WDT to be enabled/disabled, and EEPROM to be erased. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-20 NMIX-0020 Hardware Manual, Small C manuals with examples, BASIC11E9 Manual.

SBC and utility disk - $99. Keypad and LCD not included. Great value. Call today! New Micros, Inc. 214-339-2204



NEW MICROS, INC.
1601 Chalk Hill Road
Dallas, Texas 75212
Tel: (214)-339-2204

FIX ANY PC FAST!



DO-IT-YOURSELF DATA RECOVERY

RECOVER DATA FROM PHYSICALLY DAMAGED FLOPPIES & HARD DISKS IN LESS THAN 60 SECONDS!

RESCUE DATA RECOVERY SOFTWARE™ is the FASTEST, EASIEST & SAFEST method in data recovery anywhere!

For the first time you can recover a file in less than 60 seconds even when DOS cannot read a physically damaged floppy or hard disk.

Recover Text, .Exe, Graphics files, etc...You can even recover entire sub-directories with a single key stroke.

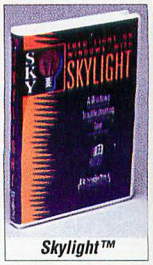
"In the past, General Failure messages left you few options. Norton, Central Point, or Mace Utilities weren't likely to help...Now there is a better solution... RESCUE can recover data from all but the most thoroughly trashed disk...RESCUE appears to work miracles..."
"Rescue, Version 4.0 offers new features and easy operation that move it out of the guru's toolbox and into the average user's library."
INFOWORLD

CALL NOW FOR PRICING!

RATED #1 FIX YOUR WINDOWS FAST!

PC MAGAZINE EDITORS' CHOICE July 1993

BEST Windows Trouble-shooting Program Available!



Skylight™

"...a model of elegance and clarity. Skylight stands out as a product that exudes intelligence in function and design."
- PC Magazine, July 93

TUNE, OPTIMIZE & TROUBLESHOOT WINDOWS for faster speed & top performance!

"Any way you can think of to slice it, Skylight can show it to you-how Windows is using memory, system resources, system metrics, GDI heap usage. This MDI-based program offers an intriguing view into the guts of Windows." **- Windows User, June 93**

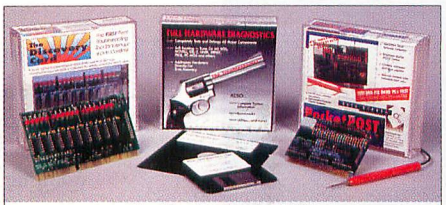
PC DIAGNOSTICS THAT REALLY FIND THE BUGS!

THE TROUBLESHOOTER™ is unlike other diagnostic programs that rely on DOS. The Troubleshooter™ bypasses DOS and tests all major hardware directly for true accuracy while other programs frequently give erroneous test results. Loaded with all the tests you need to quickly and accurately isolate the source of PC failures. Newest version includes low level formatting of I.D.E. drives and cache memory testing. Runs on any PC (with Intel or compatible C.P.U.) independent of any operating system! Priced far below all competitors.

THE DISCOVERY CARD™ is the only tool that truely ends the frustration of IRQ & DMA channel conflicts! Stop wasting time trying to "Figure-it-out" when it comes to setting up add-on cards. Perfect for anyone who upgrades PC's, sets up networks, multimedia, etc...

"If you support PC's, the Discovery Card is likely to become one of your most important tools." **-INFOWORLD, September 93**

THE POCKET POST™ is the most compact and feature packed diagnostic power-on self test (post) card in the world. Debug dead PC's in less than five minutes! Also, tests power supply and 9 bus/clock signals. Comes with a detachable logic probe.



The Troubleshooter Kit™

CALL NOW FOR PRICING!

NEW! NO MORE SYSTEM CRASHES

COOL CHIP™ is an inexpensive heat sink that can lower the operating temperature of a C.P.U. by as much as 35ºF, thus eliminating system lock-up due to excessive heat.

Excessive heat build-up within the C.P.U. is the number one cause of system crashes, lock ups, erratic behavior and intermittent failures.

COOL CHIP™ is the most effective means available to eliminate C.P.U. overheating.

"We had been experiencing various problems with system lock-ups and shut-downs, and we exhausted all other possibilities to resolve these various problems (memory, programs, power supplies, monitors, disk drives)...since the installation of COOL CHIP we have encountered no other problems."
- M.H., Certified Network Engineer

CALL NOW FOR PRICING!

The Hard Drive Kit™

EVERYTHING YOU NEED TO INSTALL, SET-UP & MAINTAIN HARD DRIVES!

DRIVE PRO™ — The all-in-one software utility for the most efficient and correct installation and maintenance of any hard drive! • Install IDE Drives in less than 60 seconds! Automatically sets CMOS, Partitions, and DOS formats without re-booting or user intervention. • DOS Format any size drive in under 30 seconds! • Drive Table Override allows almost any BIOS to have a user definable drive type. • Drive Boot Fixer is a safe alternative to low level formatting bad IDE Drives. Plus too many other features to mention!

ENCYCLOPEDIA OF HARD DRIVES™ — 3 volumes with over 1500 pages! The largest compiled reference on Hard Drives ever published!

Volume One...*SET-UP GUIDE* • Interface Types and Installation • Hard Drive Specs for over 2100 drives from 1984 to present.

Volume Two...*DRIVE SETTINGS* • Explanation of Jumper Types, Changes in Make & Model and Default Jumper Settings • Diagrams for over 1000 drives with detailed specifications.

Volume Three...*CONTROLLERS* • Over 400 Diagrams of Controllers with detailed specifications. And Much More!

THE HARD DISK TECHNICAL GUIDE™ — Comprehensive field version of the Encyclopedia with over 400 pages of vital specs! Compact to carry in the field. **CALL NOW FOR PRICING!**

VITAL HARDWARE SUPPORT AT YOUR FINGERTIPS!

Now available for the first time on CD-Rom, this Technical Library contains complete configurations, specifications, diagrams, settings, component locations, and vital information on 1500 main boards, more than 700 network interface cards, 2100 hard drive models and 400 controller cards. A must for any service department. **CALL NOW FOR PRICING!**

Technical Library on CD-Rom

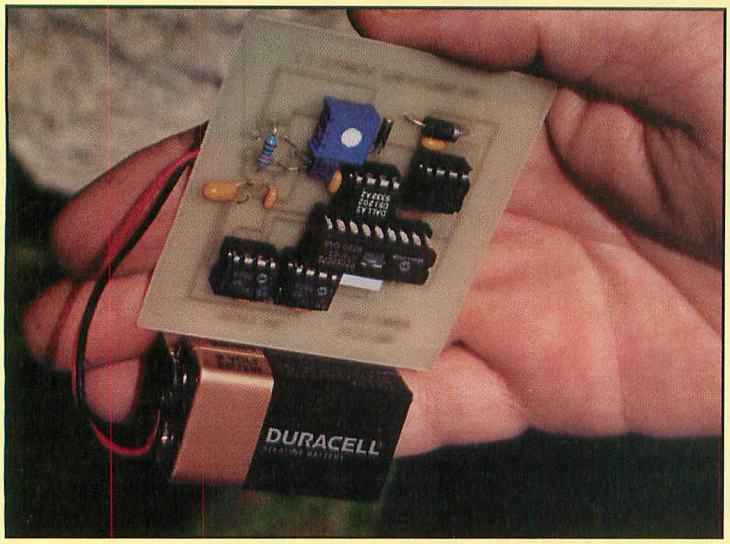
- **Free Tech Support**
- **Performance Guaranteed**
- **Next Day Shipping**

ORDER DIRECT — CALL (800) 653-4933

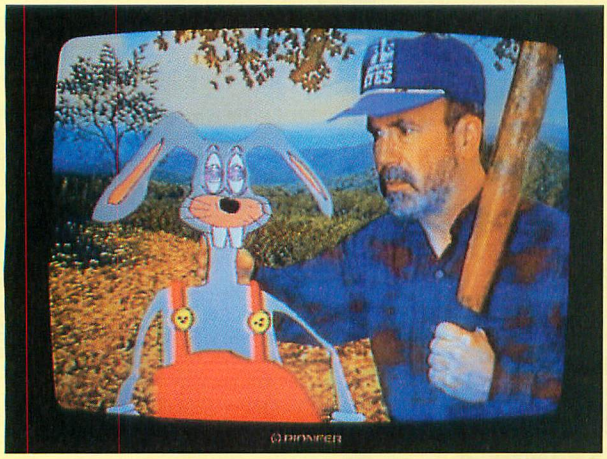
AllMicro, Inc.
18820 U.S. Hwy 19 N., #215, Clearwater, FL 34624
INT'L. (813) 539-7283 • Fax (813) 531-0200

MicroComputer JOURNAL

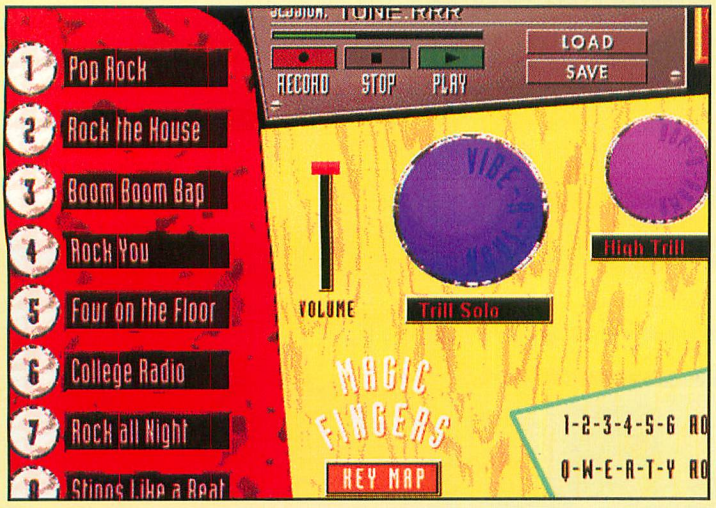
Volume 1, No. 2, March/April 1994



Page 25



Page 89



Page 92

Features

Product Review

Columns

Departments

MicroComputer Journal on MCI Mail

You can contact *MicroComputer Journal* on MCI Mail directly or through an on-line service, such as CompuServe. Any questions, article proposals, comments, etc., are welcome on this electronic mail box (MCI ID No. 456-3433) or just type: ComputerCraft.

On The Cover

The cover photo of this issue of *MicroComputer Journal* has a two-fold meaning this time around. Firstly, it shows off the hottest new technology and emerging standard to grace the portable-PC marketplace—PCMCIA. As you can see, credit-card-sized PCMCIA PC Cards are designed to slide neatly into miniature expansion-bus slots, where they nest safely out of the way during use. This new standard is capable of almost everything possible with standard desktop PCs, ranging from memory expansion to communications to hard drives to pop-in/out applications program modules and more. For complete details, see TJ Byers' "PCMCIA: Panacea or Pandemonium?" and Joe Desposito's "PCMCIA: The Mouse That Roared" articles beginning on pages 15 and 18.

The second thing our cover photo brings to the fore is a new type of product currently making a splash in the portable-equipment marketplace—PDAs, or Personal Digital Assistants. This is the main topic of discussion in Joe Desposito's "Computing On The Go" column beginning on page 96. Featured in this photo is Tandy's pocket-size Z-DA "Zoomer."

Cover Photo By Lorinda Sullivan

Editorial By Art Salsberg

Slow Movers

As speedily as things change in the computer field, and as machines perform more quickly, they're still too slow for us in many instances. CD-ROM drives, for example, continue to retrieve and display information in hare-like swiftness. That's the penalty we'll always pay when dealing with mechanical contrivances; especially when we've been spoiled by the lightning-quick action of electronic transfers from solid-state RAM.

CD-ROM drives have now moved into the mainstream of the peripherals world. Accordingly, early adopters have had their drives overshadowed by new ones in a number of ways. In terms of speediness, data-transfer and access times have been enormously improved. Starting with advances to double-speed machines, triple-speed and quadruple-speed drives followed. They're still painfully slow for non-text matter, however, much as old AT-model computers are. Unfortunately, our experiences with even hard drives and flash cards magnify the lethargic performance of any CD-ROM's information retrieve-ability. It'll improve to a point, I'm sure, but CD-ROM will always lag behind our wishes.

Microsoft *Windows* 3.1 is another slow mover, as popular as it has become. *Windows* 4.0, or "Chicago," supposedly improves on this to a great extent, but it's still in Beta release at this time. So we have a wait ahead of us. Meanwhile, there's plenty of faster DOS material around to help us bide our time until the real thing is available. Microsoft's *Windows* 4.0 won't be simply an advanced *Windows* 3.1, however. It will sport a 32-bit engine instead of a 16-bit one and will look more like a Mac desktop, while behaving like OS/2.

Additionally, DOS will be gone! *Windows* 4.0 will run DOS and *Windows* programs, though. So compatibility will still exist. A 386-microprocessor-based computer is the bare-minimum hardware platform you'll need to enter this new world.

Mobile computers are the fastest-growing segment of the computer marketplace, with notebooks becoming more and more powerful. Pen computers have surfaced, although they have a way to go before great numbers are in use. Besides, they're for great for niche functions at this time. As impressive as their handwriting translation is, they do present obstacles that slow things down. For example, too many question-mark signs pop up that require one to re-draw a particular letter or number to make the whole process fluid or seamless as you print or write. If a large part of the application consists of checking off forms, however, or for making rough drawings, they work fine for non-computerists.

Diskettes, too, are no longer a time-efficient way to distribute or archive data. With *Windows*, OS/2 and larger operating systems, as well as really large applications software programs, we find ourselves doing the "diskette shuffle" to install them. For such purposes, high-density 3½" diskettes can't hack it and aren't cost-effective.

It takes 21 diskettes to store OS/2 files on 1.44M diskettes, for example; 12 for *Windows* NT; 27 for Novell 3.11. A new technology is needed, and it's here now: optical diskettes. Growing acceptance of a particular optical diskette technology, "Floptical" diskettes are also 3½"-format diskettes. Along with an appropriate drive, each Floptical stores 21M. Thus, only two Floptical diskettes are required for the aforementioned examples, instead of the cited 12 to 27 floppy diskettes.

With the expanding use of telecommunications, file-transfer speed is of growing concern, too. A new generation of Kermit software underscores this with dramatically improved performance. It now can transmit packets in a steady stream, processing acknowledgments later. This eliminates transmission delays as well as overhead through a "sliding-window" technique that keeps multiple packets in a buffer. (For more information on Kermit, call 1-212-854-3703.)

There's no end to the quest for greater speed, naturally, so long as it's cost-effective. One day, we'll probably be working on parallel-processing machines, which are already in use. Meanwhile, we'll still meander along with a Von Neumann-based architecture.

Offices: 76 North Broadway, Hicksville, NY 11801. Telephone (516) 681-2922. FAX (516) 681-2926. MicroComputer Journal is published bi-monthly by CQ Communications, Inc. Subscription prices (payable in U.S. Dollars only): Domestic—seven bi-monthly issues $29.70, fourteen bi-monthly issues $59.40; Canada/Mexico—seven bi-monthly issues US $32.00, fourteen bi-monthly issues US $64.00; Foreign—seven bi-monthly issues US $34.00, fourteen bi-monthly issues $68.00; Foreign Air Mail—seven bi-monthly issues US $87.00, fourteen bi-monthly issues US $173.00.

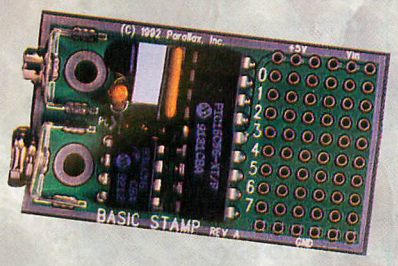
U.S. Government Agencies: Subscriptions to MicroComputer Journal are available to agencies of the United States government, including military services, only on a cash with order basis. Request for quotations, bids, contracts, etc. will be refused and will not be returned or processed.

Postmaster: Please send change of address notice to MicroComputer Journal, 76 North Broadway, Hicksville, NY 11801

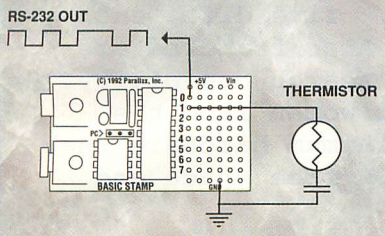
THE BASIC STAMP™

$39 Stamp-Sized Computer Runs BASIC

EDN INNOVATION '93 — DRIVING ELECTRONIC TECHNOLOGY INTO THE NEXT CENTURY



The BASIC Stamp is a 1x2-inch computer that runs BASIC programs written on your PC. It has 8 I/O lines, which can easily be programmed for serial communications, potentiometer input, pulse measurement, button debounce, tone generation, PWM, etc. And all by just adding a resistor and/or capacitor, if anything. Single Stamps sell for $39, and quantity prices start at just four units.

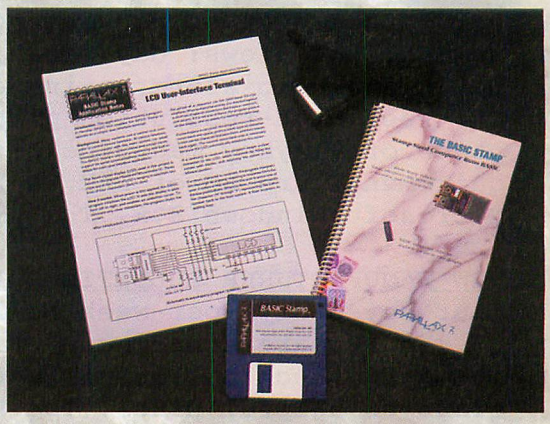


Temperature Sensor

In this application, the Stamp uses a capacitor and Radio Shack thermistor to take temperature readings. 13 BASIC instructions are used to read and linearize the input. The result is then sent out serially.

Writing programs for the Stamp is easy. A 3-pin cable connects the Stamp to your PC's parallel port. And one piece of software is used to enter, debug, and download your programs. It's as simple as possible.

All that you need to program Stamps is included in the Stamp Programming Package. The package contains the cable and software mentioned above, as well as a manual, application notes, and access to free technical support.



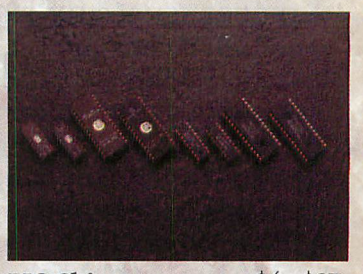
Stamp Programming Package **$99**

PIC®16Cxx MICROCONTROLLERS and TOOLS

Inexpensive and available, PICs are building a following

You may already know about the PIC16Cxx series of 8-bit microcontrollers from Microchip Technology. They're the answer to many small controller needs, especially if price if an issue. A typical PIC is the PIC16C54-RC/P; it's an 18-pin DIP package with 12 I/O lines, 512 words of PROM, and 32 bytes of RAM, all for around $4.00 in small quantities. And the series continues to grow: new PICs have interrupts, A/D, and up to 33 I/O lines.

For the past three years, we've been helping people get started with PICs. We offer low-cost development tools, documentation, application notes, and technical help, as well as the PICs themselves.



PIC Chips **$4 - $27**

We offer PICs in the "RC" and EPROM versions.

PIC16Cxx Programmer **$199**

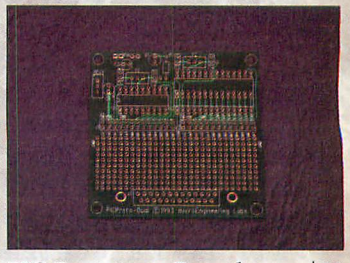
Supports PIC16C5x, '71, & '84. Also PIC16C64 with 40-pin adapter.

PIC16C5x Downloader **$299**

Plugs in place of '5x PIC in-circuit. Runs code at 8 MHz.

TrueFlight™ for '71/'84 **$299**

Programmer & flash UV eraser form development system for '71 & '84.



PIC Prototype Board **$15**

Provides an easy way to develop circuits with 18- and 28-pin PICs.

PARALLAX INC™

3805 Atherton Road, #102 • Rocklin, CA 95765 • USA
(916) 624-8333 • Fax: 624-8003 • BBS: 624-7101

VISA MasterCard

WHEN COMPUTERS AREN'T COMPUTERS. The U.S. Customs Service announced that it would no longer charge a 3.9% duty on computer equipment manufactured abroad and imported into the U.S. if the microprocessor is not installed until afterwards. Lawyers for importer Daewoo developed the legal strategy for such goods not being classified as a computer. That is, without the CPU the machine doesn't have the characteristics of a computer, overturning a 1982 decision. Putting salt in the deficit wound, Customs will refund, with interest, all such duties that had previously been paid!

A PLAYBOY DATA BOOK. Playboy Enterprises has introduced its Playboy Electronic Datebook, which combines the look and feel of a traditional notebook planner with a host of conveniences, including "click and drag," five different at-a-glance views: day, week, month, year and to-do lists. Also featured are built-in audio alarm, print ability in many sizes and fast search capability. Oh, yes, high-resolution graphics of more than 50 beautiful women from the pages of Playboy magazine promise to brighten one's day. Minimum hardware requirements are 2M of RAM, a hard-disk drive with at least 4M free space and Microsoft Windows 3.x. The program is priced at $59.95.

NEW MANUFACTURER BULLETIN BOARDS. BASF Corp. Information Systems opened a 24-hour seven-days-per-week bulletin board dedicated to storage media. As part of the BBS are standing BASF application engineering papers, current news items and tech bulletins. Users can post notes ranging from technical questions to helpful hints. The BBS is staffed by technical and support people around the world. Users should set their modems and communication software to no parity, eight data bits, one stop bit. 9,600 baud is supported. To reach the free service, dial 617-271-6599.

Rigel Corp. of Gainesville, FL, also started a bulletin board for the 8051 microcontroller family. It'll be a user's guide/forum, with free software, demo software, listings of product vendors, technical support and product information. The phone number is 904-377-4435.

TROUBLESHOOTING/MAINTENANCE AIDS. Landmark Research of Clearwater, FL, announced its new troubleshooting software tool, Landmark SCSI Certify. The $249 package is designed to help the user identify, troubleshoot and configure SCSI peripherals: hard drives, optical drives and CD-ROM drives.

Champions Management Support Services, Downington, PA, released its new PC Computer Maintenance Annual Version 6.0, which covers 8086/8088-based PC through 586-based Pentium computers and peripherals and Macintosh models. With more than 500 pages of data, it gives technicians specific procedures to resolve problems. It comes in a ring-style binder, and a subscription updating service is available. Call 301-604-9248.

Fidex Americas Corp. of Sandpoint, ID, introduced a source-code escrow service called, Software Security Service. It's designed to give software developers a way to alleviate their clients' concerns should they go out of business, the key writer gets hit by a truck or some other catastrophe strikes. (Half the software companies in the U.S. employ three people or less.) The essence of the problem is that custom software is the property of the software developer, not the client who paid to have it written, according to U.S. Copyright Law. Thus, the writer holds the source code, while delivering only executable programs. To guarantee that the client's custom software will be maintained for as long as it's needed, the software developer deposits a copy of the source code with Fidex Americas, along with a written agreement between developer and client that details events that would trigger release of the source code to the client. Deposited materials are stored in a climate-controlled subterranean vault. For information, call 800-569-7569.

Memories

• I was dismayed to read in the January/February 1994 edition of *MicroComputer Journal* that you recommend that notebook-computer batteries be completely discharged to prevent the "memory" effect. I strongly urge you to reconsider this advice because the memory effect simply doesn't exist for practical purposes. The myth of the memory effect started in the late 1960s or early 1970s, when it occurred in the batteries on a communications satellite. Early reports of the memory effect spread much faster than the more-complete follow-up information that the effect occurs only under a set of conditions that simply won't occur in a notebook computer. Even when these conditions do occur, memory seldom actually happens. And when it does happen, the battery doesn't "simply quit." It has a a slightly reduced output voltage that would probably not produce any change in the performance of the computer. In other words, if your batteries did suffer from "memory," you probably wouldn't know it.

More importantly, the two fastest ways to destroy Ni-Cd cells are to overcharge them and to reverse-charge them. If a notebook computer has a properly designed charging circuit (which is likely, but not guaranteed), overcharging isn't a danger. Deep discharge of a battery pack, however, runs a very high risk of reverse-charging some of the cells in a pack. This is because some cells will reach full discharge before the rest in the pack. As the rest of the pack continues to discharge, cells at zero charge will begin reverse charging. The result is rapid deterioration of the reverse-charged cells.

Your computer may have circuitry that protects the battery pack by turning off while the battery is still at a safe voltage, but why risk it? The ultimate lifetime of an Ni-Cd cell is largely determined by how much total energy is provided. Why shorten its potential life by discharging it more than necessary?

Please do your part to stamp out the myth of the dreaded "memory" effect. You'll be doing your readers a favor, since the proposed cure is likely to result in quite a few dead batteries and is far worse than the "disease" it purports to cure.

Robert E. Johnson, P.E.
Ambient Systems
Gainesville, FL

POST Improvement

• Regarding your "Build a POST Card" article in the November 1993 issue of *ComputerCraft*, a much better choice of decoder integrated circuit for the displays would be type 9368. This device is a four-bit latch, decoder and seven-segment LED driver. Most importantly, it provides full hexadecimal display. It's available from Jameco Electronics for just under $3.

Michael Kiley
Crestwood, IL

Fluff Fears

• I've been reading *ComputerCraft* for the past few months now, and I must say that it's the best magazine I've ever subscribed to. Its microcomputer and microcontroller articles and projects are the kind that I've been looking for in other publications, to no avail, and I was delighted when I discovered *ComputerCraft* in my local library.

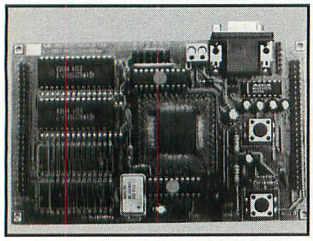
I am, however, a bit concerned, after reading the November 1993 Editorial, of you plans to rename the magazine to *MicroComputer Journal* and change its "editorial mission." I look forward every month to receiving *ComputerCraft*

(Continued on page 110)

Hardware

Microcontroller Evaluation Board

The RMB-166 is an evaluation board for the Siemens 80C166 16-bit microcontroller. On this board, the 80C166 is configured to run at 40 MHz with 0 wait state. Several memory options are supported, including 64K of RAM, using two 62256 chips; 256K of RAM, using two 681000 chips; and 64K of EPROM, using two 27256 chips. The default configuration is 64K of RAM with no EPROM. In this configuration, the monitor program or user program is downloaded to RAM using the 80C166 bootstrap feature.



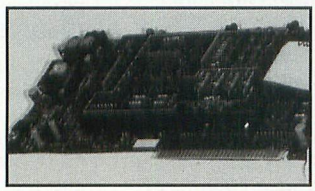
A set of option headers, decoded by PAL devices, enhances the flexibility of the RMB-166. All system address, data and control lines and microcontroller Ports 2, 3 and 5 are terminated at two 50-post headers. Ports 2 and 3 are 16-bit general-purpose I/O ports, while Port 5 permits 10 bits of analog or digital inputs. Both 80C166 serial ports are available at RS-232 levels through a six-post connector. Serial Port 0 is also connected to a female DB-9 socket, which is used to communicate with a PC host. The board measures 3½" x 5¾".

Also included in the package is PC host driver software READS166 (Rigel's Embedded Applications Development System) and a downloadable monitor program RMON-166. Both are intended as introductory-level tutorial software systems. READS166 requires a PC host running MS *Windows* 3.1 with one serial port. $395. *Rigel Corp., PO Box 90040, Gainesville, FL 32607; tel.: 904-373-4629.*

CIRCLE NO. 1 ON FREE CARD

Load Cell Interface Card

Tedea-Huntleigh's LCIC-1106 is a load cell interface card for PC/AT compatible computers. The card has 16-bit internal resolutions, resides directly on the PC bus and powers up to six strain-gauge cells. The



LCIC-1106 handles real-time data acquisition for high-speed check weighers, batching controllers, weighing-in-motion truck scales, peak force measurements and other dynamic applications. *Tedea-Huntleigh, 7800 Deering Ave., PO Box 7964, Canoga Park, CA 91309; tel.: 818-884-6860; fax: 818-340-1175.*

CIRCLE NO. 2 ON FREE CARD

PC-to-TV Card

VideoOut from International Computers lets you display a computer screen on a TV receiver or save it to a VCR tape. It consists of a plug-in card and TSR software. VideoOut is capable of displaying both text and graphics and both black-and-white and color screens. It's claimed to be compatible with all VGA boards and to detect the board manufacturer so that configuration isn't necessary. $99. *International Computers, 12021 W. Bluemound Rd., Wauwatosa, WI 53226; tel.: 414-764-9000.*

CIRCLE NO. 3 ON FREE CARD

Mini Overheads

Mini Overhead Transparencies from Graphic Accent are down-sized, color, overhead transparencies designed to replace full-sized color overheads without loss of image quality. Advantages include a 75% reduction in size and weight and 20% to 30% reduction in cost. These mini transparencies are said to project on any standard overhead projector via a fold-away optical adapter

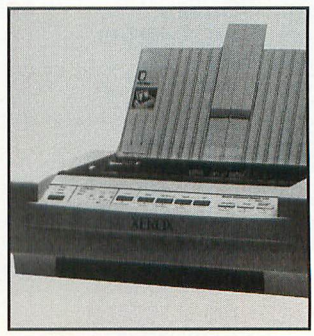
stand. *Graphic Accent, Inc., 446 Main St., Box 243, Wilmington, MA 01887; tel.: 508-658-7602; fax: 508-658-8011.*

CIRCLE NO. 4 ON FREE CARD

Ink-Jet Printer

The Xerox Personal Printer 4004 is a 300 x 300-dpi-resolution ink-jet model that produces two lines of text or graphics in a single pass due to a printhead with 128 nozzles. This yields approximately three pages of text a minute. The printer is equipped with an integral 100-page automatic sheet feeder. The Xerox ink-jet printhead and attached reservoir of ink are built as a replaceable cartridge. Each cartridge is rated to print about 1,400 pages of text and contains a water-based ink developed by Xerox that quickly dries on contact with paper. The Model 4004 supports three typeface families. $299. *Xerox Corp., Xerox Square-05B, Rochester, NY 14644; tel.: 716-423-5078.*

CIRCLE NO. 5 ON FREE CARD



Parallel-Port Frame Grabber

Digital Vision's Computer-Eyes/LPT real-time parallel port frame grabber lets you capture high-quality eight-, 16- and 24-bit color images on a PC/compatible computer from any standard video source, such as a VCR, camcorder, laser disk or still video camera. Instantaneous frame grab lets you capture even fast-moving subjects from TV broadcasts, video tape and live camera action.

ComputerEyes/LPT features a 1/30 second capture time and 640 x 480 capture resolution at up to 24 bits per pixel. The unit has two video inputs, one for composite video and the other for S-video. Both NTSC and PAL versions are available. Captured images can be saved to .TGA, .TIF, .PCX, .GIF or .BMP file format. $399.95. *Digital Vision, Inc., 270 Bridge St., Dedham, MA 02026; tel.: 617-329-5400; fax: 617-329-6286.*

CIRCLE NO. 6 ON FREE CARD

50-MHz Cyrix-Based PC

The MicroFLEX-VL/D50 from Micro Express is a VESA-standard local-bus PC based on the 50-MHz Cyrix Cx486DX-50 chip and is also upgrade-able to the Pentium. The system includes 4M of RAM, 240M hard-disk drive with IDE caching controller (1M of disk caching), 5¼" and 3½" high-density floppy-disk

B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
(214) 271-5546
FAX (214) 271-2462

VISA MasterCard

NEW ITEMS! NEW PRICES! NEW ITEMS! NEW PRICES!

LCD DISPLAYS

OPTREX 2x16-DMC 16207H-8 Bit ASCII Input Dim. 3 1/8x1 1/4x3/8 Char. Height .19"	$5.99
OPTREX 2x20-DMC 20261-8 Bit ASCII Input Dim. 4 1/16x1 1/8x3/8 Char. Height .19"	$7.99
OPTREX 1x16 "Backlit"-DMC 16187-8 Bit ASCII Input Dim. 3 1/8x1 3/8x9/16 Char. Height .11"	$9.95
OPTREX 1x20-DMC 20171-8 Bit ASCII Input Dim. 7 9/16x1 9/16x1/2 Char. Height .42"	$9.95
OPTREX 2x40-DMC 40218-8 Bit ASCII Input Dim. 7 9/16x1 9/16x1 3/32 Char. Height .19"	$9.95

VERY EASY TO INTERFACE TO ALMOST ANY MICROPROCESSOR!!!!!!

LTP 1157 AE

1.2' 5x7 Matrix Displays
5x7 Array with x.y select. This Red Orange Matrix Can Be Stacked Horizontally. Matrix Orientation - Cathode Column, Anode Row.
WITH DATA
Great For "Moving Message" Signs.
$1.19 Ea., 8/$6.95, 100/$75.00

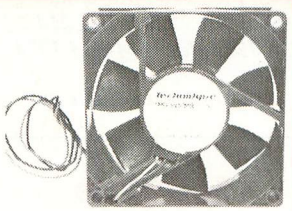
DTMF

SSI-202 Decoder	2.25
8870 Decoder	2.25
5087 Generator	2.00
5089 Generator	1.25

UART

NS16450	6.50
16550	10.95
TR1602B (COM 2017)	1.75
IM6402 +5v High speed	
AY5-1013 pin out	2.45
INS 8250	2.95

FANS



SANYO—BRUSHLESS
12 Volt DC at .07 Amps—
7 Blades
60 MM—2 3/8"x2 3/8"x1"
$5.95

TECHIDYNE—Brushless
12 Volt DC at .12 Amps—
7 Blades
80MM—3 1/8"x3 1/8"x1"
This size commonly used in Computer Power Supplies
$5.90

PANAFLO—Brushless—12 Volt DC at .2 Amps 5 Blades—
119MM—4 11/16"x4 11/16"x1 1/2"
$5.99

8000/80000

8001	5.20	8237	1.90	8088-2	3.25	8257	1.50
8002	$2.50	8237-5	2.80	8155	2.25	8259A	1.85
8010	4.95	8243	1.75	8156	2.25	8259C-5	2.10
8031	2.95	8250	2.95	8202A	8.00	8275	10.95
8032	3.95	(16450)	6.50	8212	1.25	8279	2.25
8035	1.00	(16550)	10.95	8214	2.00	8284	1.49
8036	4.95	8251	1.10	8216	1.25	8286	3.50
8039	1.00	8253-5	1.75	8224	1.25	8287	2.49
8085	1.55	8254	1.80	8228	1.75	8288	3.50
8086	1.55	8255	1.50			8530	3.00
8088	2.20	8255-5	1.75				

STATIC RAM

2016-2KK8 200 n.s.	1.00
2101-1 - 256X4 500 n.s.	.75
21L02-1 350 n.s.	.65
2102AL-4 L.P. 450 n.s.	.49
2111-1 256X4 500 n.s.	1.00
2112A-2	2.50
2114L-3 1KK4 300 n.s.	.45
2125A-2 1KK1 70 n.s.	1.00
2147 4KX1	1.00
2148	1.00
6116P-4	1.00
6117	1.20
6264	1.40
62256 32KX8	5.00
128KX8	15.00

DYNAMIC RAM

2108-4 8KX1	1.50
2118-4 16KX1-5Volt	.70
4027-4KX1-260 n.s.	.80
4116-16KX1-250 n.s.	.40
4116-16KX1-200 n.s.	.75
4116-16KX1-150 n.s.	.90
4128 Piggyback	2.00
4164-150 n.s.	.49or9/3.50
4164-120 n.s.	1.10
4164-100 n.s.	1.40
TMS4416-16KX4-15- n.s.	2.75
4464-150 n.s.	1.40
4464-120 n.s.	1.45
4464-100 n.s.	1.45
4464-80 n.s.	1.45
41256-150 n.s.	1.25 or 9/9.95
41256-120 n.s.	1.30 or 9/10.99
41256-100 n.s.	1.30 or 9/10.99
41256-80 n.s.	1.30 or 9/10.99
41256-60 n.s.	1.85
1 Meg - 100 n.s.	4.40
1 Meg - 80 n.s.	4.40
414256-80 n.s. 256 x 4	4.60

SIPPS, SIMMS, & CACHE AVAILABLE

EPROM SPECIAL

We bought a large quantity of 2708s, 2716s, 2532s, 2732s, 2764s, 27128s, 27256s and 27512s from a computer manufacturer who re-designed their boards. We removed them from sockets, erased and verified them, and now we offer the savings to you. Complete satisfaction guaranteed.

Your Choice	
2708 1/20	10/8.00
2716 1.75	10/15.00
2532 2.00	10/17.50
2732 2.00	10/17.50
2764 2.00	10/17.50
27128 2.50	10/20.00
27256 3.00	10/25.00
27152 4.75	10/40.00
1 Meg 8.50	10/77.50

EPROM

8741	7.00
8742	7.00
8748	7.00
8749	7.00
8751H	12.95
8755	7.00

PROMS

82S123	1.49
82S126	1.49
82S153	1.75

LOCAL AREA NETWORK

NETWORK

Little Big LAN

- Peer to Peer LAN, to 250 nodes
- $75 total software cost! No matter how many nodes!
- Use ARCnet, serial, parallel or Ethernet to link your computers.
- Mixed mode routing Any combination of above connections is possible on any given node.
- RAM needed approx. 35-45K
- Uses DOS versions 2 and above, 3.1 and above preferred.
- Print spooling
- Record locking via Dos SHARE
- Open network, API provided
- Runs ok with Windows 3.0
- Drive A-Z can be redirected to reference any drive on any computer. LPT1-LPT3 can print to any printer.
- "Start small, grow as you grow"

$75.00

CUSTOM CABLES

Cables Also available for Little Big Lan
Serial (5 Wire Null Modem) - $10.00 for First 6 ft. 25¢ a foot after 6 feet (Custom Cables Non-Refundable)
Parallel - Adapter $10.50
Adapt Most 25 pin to 25 pin cables to meet the Parallel interface requirements.
Arcnet - 50¢ a ft (Twisted Pair Only)
Ethernet - 50¢ a ft (ThinNet RG 58)

LAN CABLE

Another B.G. Micro Exclusive ... 25 feet of Etjernet RG 58A/U Coax with a BNC connector, a BNC "T", and a BNC terminator on each end.
No one can beat this price. - $7.95
Additional "T" - $.99

NETWORK CARDS

- 16TB Model - Complies with IEEE 802.3
- Standards for 10Base-T and 10Base2.
- Works with most popular network softwares including Netware, TCP/IP, Windows for
- Workgroups, LANtastic, and etc,.
- On-board 16K RAM for Multi-packet Buffers.
- Four LEDs to indicate link, transmit/ receive, polarity/Jabber, and collision status.
- Automatic polarity detection and correction of writing errors.
- Jabber function (Watchdog timer).
- Novell Approved NE 2000 Compliant

$67.99

- NE 1000 Available (Call)
- Arcnet Available (Call)

NEW PRICES! NEW ITEMS! NEW PRICES! NEW ITEMS!

TERMS: (Unless specified elsewhere) Add $3.25 postage, we pay balance. Orders over $50.00 add 85¢ for Insurance. No. C.O.D. Texas Res. add 8 1/4% Tax. 90 Day Money Back Guarantee all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico or Puerto Rico. Canada, add $7.50 minimum shipping and handling. Countries other than Canada, add $15.00 minimum shipping and handling.

CIRCLE NO. 56 ON FREE INFORMATION CARD

drives, VESA-standard local-bus video card, Micro Express FM-370 14" SVGA video display monitor, 256K of external cache RAM, mouse, DOS 6.0 and *Windows* 3.1.

The MicroFLEX-VL/D50's mini-tower system unit has provision for three accessible 5¼" disk drives, one accessible 3½" disk drive, two 3½" and one internal 5¼" internal disk drives. The computer's proprietary motherboard features eight expansion slots, including two 32-bit VESA local-bus, five 16-bit and one eight-bit slot slots. Sockets are provided for up to 32M of RAM on the motherboard. The computer uses the AMI BIOS. $1,899. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400; fax: 714-852-1225.*

CIRCLE NO. 7 ON FREE CARD

Microcontroller Tool

Electronic Product Designs' Micro Controller Tool (MCT) is a complete PC-based development system for the Philips/Signetics 87C751 and 87C752 microcontrollers. Both microcontrollers feature 2K of EPROM, 64 bytes of RAM, 19 I/O lines, five interrupt sources and low-power modes. The units are packaged in UV-erasable or one-time programmable versions. The 87C752 also has a built-in five-channel, eight-bit A/D converter and pulse-width-modulation output for D/A conversion.

The MCT development system is an optimized and integrated package that includes a project manager, text editor, assembler and programmer. MCT offers sample start-up programs and an expandable library that includes 32-bit math, LCD and serial routines. $399. *Electronic Product Design, Inc., 6963 Bluebelle Way, Springfield, OR 97478; tel.: 503-741-0778.*

CIRCLE NO. 8 ON FREE CARD

Portable Security Alarm

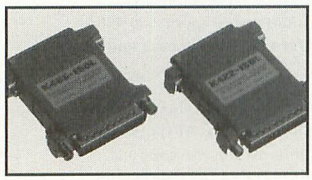
Security and Safety Warehouse's SonicPRO motion sensor alarm, which mounts with 3M double-bonded tape to portable electronic equipment, allows you to customize for alarm sensitivity, alarm duration, delay, and two levels

of ID access. When activated, SonicPRO provides a 110-dB alarm sound. $79. *The Safety and Security Warehouse, 1740 O'Farrell St., San Francisco, CA 94115; tel.: 800-404-9266; fax: 415-441-0384.*

CIRCLE NO.9 ON FREE CARD

Isolated RS-232-to-RS-422 Converters

The K422-ISOL and K485-ISOL from Saelig are self-powered devices that provide instant isolated conversion from RS-232 to RS-422 or RS-485 when plugged into a PC's serial port. Isolation is claimed



to be 100% tested to greater than 200 volts ac rms. The units support baud rates from 0 to 38,400. $139 each. *The Saelig Co., 1193 Mosely Rd., Victor, NY 14564; tel.: 716-425-3753; fax: 716-425-3835.*

CIRCLE NO. 10 ON FREE CARD

Virus Card Upgrade

Multix's ViruStop PC Immunizer Card now operates with an EEPROM. In the event the card requires upgrading, the upgrade can be performed by downloading from floppy disks. ViruStop works on XT, AT, 386 and 486 machines. $79. *Multix, Inc., 4203 Beltway Dr., Ste. 7, Dallas, TX 75244; tel.: 214-239-4989; fax: 214-239-6826.*

CIRCLE NO. 11 ON FREE CARD

RAID-1 IDE Controller

Perceptive Solutions' quickRAID is a caching RAID-1 disk-mirroring controller that protects data against hard-disk crash by maintaining two complete copies of the data on two different IDE drives. Data is always accessible because quickRAID accesses the only working drive. quickRAID is said to assure compatibility with its industry-standard WD-1003 interface and its adherence the ATA IDE standard. Once installed, quickRAID is completely transparent to all PC standard operating systems. The card comes with a 512K cache memory, which is expandable to 8M. A graphical utility is included to set up the drives. $344. *Perceptive Solutions, Inc., 2700 Flora St., Dallas, TX 75201; tel.: 214-954-1774; fax: 214-953-1774.*

CIRCLE NO. 12 ON FREE CARD

Software

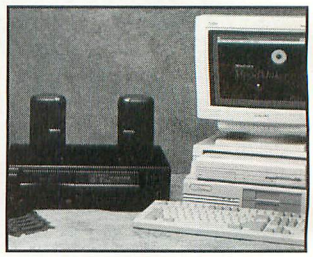
City Mapper

News Electronic Data's *Taxi* mapping software product for *Windows* describes in minute detail the locations of hotels, restaurants and landmarks in five major American cities. *Taxi* includes data for New York, Chicago, Washington, D.C., Los Angeles and San Francisco. The program pinpoints any given address on a city map, constructs convenient routes for travelers to find an address and then identifies hotels and restaurants according to Zagat food, decor, service and price ratings, other index criteria and surveyor comments. $69.95. *News Electronic Data, Inc., 28 Center St., Clinton, NJ 08809; tel.: 800-HEY-TAXI.*

CIRCLE NO.13 ON FREE CARD

CD-Library Cataloguer

MoodMaker from Kenwood U.S.A. is *Windows* software for cataloging and playback of entire CD libraries. It catalogs according to artist, composer, title, music type, mood, label and other options. The program also lets you scan in album cover art, which is then reproduced on your computer's video screen in tandem with musical selections.



Originally developed to interrconnect a PC with the Kenwood DP-M7750 multi-disc CD player *MoodMaker* now can be used independently of the CD hardware. Kenwood player owners, however, can program their selections and have the playback process totally automated. $29.95. *Kenwood U.S.A., Corp., PO Box 22745, 2201 E. Dominguez St., Long Beach, CA 90801; tel.: 310-639-9000.*

CIRCLE NO. 14 ON FREE CARD

Plotter Emulator

PrintAPlot Pro plotter emulation software from Insight Development incorporates an ADI driver that enables users to plot to more than 1,200 laser, ink-jet, PostScript and dot-matrix printers at resolutions ranging from 75 to 600 dpi. All CAD and graphics software users can now convert HPGL/2 and HPGL files, preview each plot before printing and print continuous long plots. In *AutoCAD*, *PrintAPlot Pro* works entirely in the background; with *MicroStation*, *CADKEY* and all other CAD software applications, *PrintA-*

Plot Pro works as a TSR pop-up program or in stand-alone mode.

The program includes support for 255 pens and 25 paper sizes. You can change pen and line widths, patterns and colors, tile A- to E-size drawings, adjust plot scaling and rotation and batch print to a stand-alone printer or Novell *NetWare* queue. $199. *Insight Development Corp., 2420 Camino Ramon, Ste. 205, San Ramon, CA 94583; tel.: 510-244-2000; fax: 510-244-2020.*

CIRCLE NO. 15 ON FREE CARD

DOS Helper

Flambeaux Software's *DOS Help!* Version 6.0 is a complete hypertext on-line reference and tutorial for the commands and topics of MS-DOS 6.0. This release provides in-depth coverage of new features of DOS, including DoubleSpace, MemMaker, MultiConfig Menus, InterLink, Defrag, MS-AntiVirus and MS-Backup. The *DOS Help!* 6.0 database is fully cross-referenced and indexed, making it easy to find answers to DOS questions. The indexes include an alphabetic index of commands and topics, commands by functional groupings, a subject index and a beginner command set.

DOS Help! 6.0 employs the new Viewer that was released with the hypertext authoring system *xText* 2.0. *DOS Help!* 6.0 can be used as a TSR program and consumes only 5K of conventional memory while inactive. $49.95. *Flambeaux Software, 1147 E. Broadway, Ste .56, Glendale, CA 91205; tel.: 800-833-7355; fax: 818-957-0194.*

CIRCLE NO. 16 ON FREE CARD

Automated File Processor

Blue Rithm Software's *Aeris* automated file processing system enables you to search for and rearrange files and records in an unlimited number of ways to suit your particular requirements. The program handles all file-processing requirements, from simple and complex searches to extracts, multi-key sorts, conversions, cuts, pastes, merges, file translations, reformatting, parsing and calculations. *Aeris* is specifically built to handle custom file processing applications and has high-level script commands and functions that can access all or parts of files in a single action. The program is available in both DOS and *Windows* versions. $129.95. *Blue Rithm Software, 21823 N. Glen Dr., Colbert, WA 99005; tel.: 509-468-1434; fax: 509-467-2699.*

CIRCLE NO. 17 ON FREE CARD

87C750 Developer's Kit

Micro Computer Control's 87C750-SDK software development kit for the 87C750 microcontroller from Philips Semiconductor includes MICRO/EDITOR, a full-featured, multi-window text editor; MICRO/ASM-750, a macro assembler; and MICRO/ SLD-750, a simulator and source language debugger. This DOS-based development package is especially configured to support an 87C750 target processor environment, including memory spaces and peripheral ports and timers. Also supported is a source debug environment that includes instruction single-stepping, breakpoints, watch windows and more than 17 additional tools. $99.95. *Micro Computer Control Corp., PO Box 275, Hopewell, NJ 08525; tel.: 609-466-1751; fax: 609-466- 4116.*

CIRCLE NO.18 ON FREE CARD

Chess

Socrates 3.0 is the latest and best of the family of Socrates chess programs from Machiavelli Designs. The program combines state-of-the-art artificial intelligence with ease of use, and has a BT rating of 2315. Recommended configuration is a 50-MHz 486DX computer with 4M of RAM. The program includes mouse support. $149.95. *Machiavelli Designs, Inc., 2550 Ninth St.,*

Ste. 204, Berkeley, CA 94710; Tel.,: 510-841-4634; fax: 510-486-0632.

CIRCLE NO. 19ON FREE CARD

Screen Extender

Stairway Software's *ScreenExtender* 3.0 is a major upgrade to the popular *WordPerfect* screen utility. The program eliminates the left-right screen scrolling that occurs while editing a document that contains proportionally spaced and/or scaleable or compressed fonts.

ScreenExtender 3.0 lets you choose from 25 screen sizes, display up to 144 characters per line and change screen sizes on demand while inside *WordPerfect*. With this program, you can work with up to an entire page of fully-readable text on-screen without changing from the edit screen to print preview.

ScreenExtender 3.0 supports expanded, extended and upper memory and requires up to 52% less conventional memory than previous versions. The program supports *WordPerfect* 5.0 and 5.1 and the new *WordPerfect 6.0 for DOS*. $99.95. *Stairway Software, Inc., 913 First Colonial Rd., Ste. 102, Virginia Beach, VA 23454; tel.: 804-437-7000; fax: 804-437-7077.*

CIRCLE NO. 20 ON FREE CARD

Digital Morphing

HSC Digital MORPH from HSC Software is image, animation and video morphing and warping special-effects software for *Windows*. You can morph from one still image to another or between moving video and animation files. Animation and paint tools are included to further enhance morphs, warps and final output for *Video for Windows* or Autodesk animation files. Worphs or warped morphs can also be performed, generating animation or *Video for Windows* files. Cutouts allow portions of an image to be cut out and then moved, sized, scaled and rotated.

Morphs, warps and cutouts can be animated from within *Digital MORPH* and played back using *HSC InterActive* or any .AVI- or .FLC-compatible program. $149. *HSC Software, 1661 Lincoln Blvd., Ste. 101, Santa Monica, CA 90404; tel.: 310-392-8441; fax: 310-392-6015.*

CIRCLE NO. 21 ON FREE CARD

PC Protection

Stiller Research's *Integrity Master* has been enhanced to completely check data files and all areas of a PC for correct operation. The program thoroughly checks all files, recognizes known viruses, checks boot and partition sectors and intelligently checks CMOS. It checks the CMOS areas that can affect correct operation of the PC and reports exactly what has changed. If needed, *Integrity Master* restores CMOS to its original working state. The product includes a 112-page manual that provides a thorough explanation of threats to data integrity, with special emphasis on viruses. $35. *Stiller Research, 2635 Ridgeway St., Tallahassee, FL 32310; tel.: 314-256-3130; fax: 314-966-1833.*

CIRCLE NO. 22 ON FREE CARD

Time Tracker

Win, What, Where is a time-tracking and usage monitor for *Windows* from Basic Systems. Working in the background, this program automatically tracks every activity in the *Windows* environment. It's useful for tracking time, recreating and analyzing problems through history files and as a personal-productivity monitor. $35. *Basic Systems, Inc., 2103 W. Canal Dr., Kennewick, WA 99336; tel.: 800-242-4775; fax: 509-735-1730.*

CIRCLE NO. 23 ON FREE CARD

Windows Text Editor

WinEdit 3.0 is a professional text editor from Wilson WindowWare for *Windows* 3.1 and *Windows NT*. There are three versions of the product: professional, standard and lite. All provide up to 16M of file capacity, dual-page printing in landscape mode, 2,000-level undo and redo, auto indent, keystroke record and playback and other features.

WinEdit Standard and *Professional* are software-development tools that add project management capabilities. The programs are pre-configured to support developers who use such popular programming languages as Microsoft Assembler, Borland C++ and *Clipper*. *WinEdit Standard* and *Professional* provide "syntax coloring" for many development languages so that code elements are presented in the most-direct way possible.

With *WinEdit Professional*, development can be automated using the WIL script language. DDE and OLE 2.0 automation are supported via WIL. $29.95/$59.95/$89.95/$129.95. *Lite/Standard/Professional/Professional for NT. Wilson WindowWare, Inc., 2701 California Ave. SW, Ste. 212, Seattle, WA 98116; tel.: 206-938-1740; fax: 206-935-7129.*

CIRCLE NO. 24 ON FREE CARD

Electronic Design Software for *Windows*

TangoPRO

Accel Technologies' *TangoPRO* Version 2.0 is a complete integrated system for printed-circuit-board design under *Windows*. Major new features of this latest version include complete forward and backward ECO support; hot-linked cross-probing between schematic and PCB; integrated component libraries; and more than 20 other enhancements to improve design quality and engineering productivity. The *TangoPRO* design system includes Schematic, PCB, Route and Library Manager.

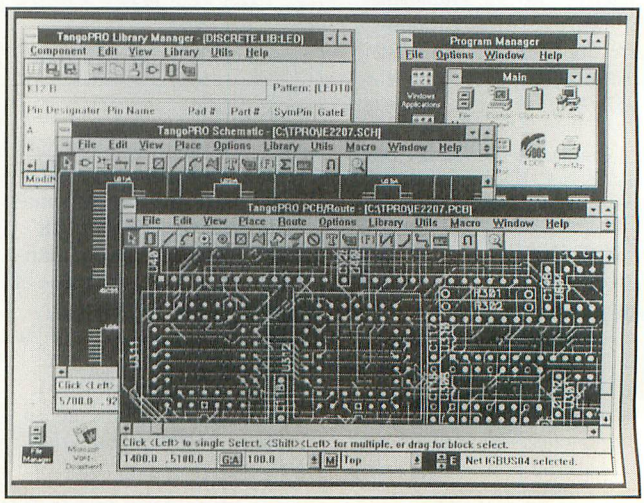
TangoPRO Schematic features intelligent wires, unlimited viewing options, automatic junctions and bus connections, visual clues for open connections and rules violations, macro support and single entry command shortcuts.

TangoPRO Schematic Lite and *TangoPRO PCB Lite* are identical in look and feel with their full program counterparts, but they're limited in capacity to 200 components and 500 nets, and some other features have been abridged. $1,495/$5,950/$5,500/$595/$1,995. *TangoPRO Schematic/PCB/Route/ Schematic Lite/ PCB Lite. ACCEL Technologies, Inc., 6825 Flanders Dr., San Diego, CA 92121; tel.: 800-488-0680.*

CIRCLE NO. 25 ON FREE CARD

Advanced Schematic, PCB and *SB Route*

Protel Technology's *Advanced Schematic* 2.0, *Advanced PCB* 2.0 and *Advanced SB Route* electronic-design programs run under *Windows* 3.1. *Advanced Schematic* 2.0 provides a host of new features to automate



schematic drawing, including guided wiring, find-and-replace text editing and global editing across projects. The new release includes support for EEs of simulation packages, enhanced support for SPICE and EDIF netlists and a new font-management system. *Advanced PCB* includes direct loading of *PADS 2000 PCB* files, padstack support, pick-and-place output and fully editable copper pours with arcs. The program is a 32-bit system with an overall resolution of 0.001 mil. Advanced SB Route uses shape-based descriptions of design elements and user-specified manufacturing rules to precisely define autorouting problems and achieve maximum completion rates. The program lets you define routing requirements for specific components, nets and pad-to-pad connections, and it includes support for high-density through-hole and SMD components. $995/$2,795/$9,900, *Advanced Schematic/Advanced PCB/ Advanced SB Route. Protel Technology, Inc., 4675 Stevens Creek Blvd., Ste. 200, Santa Clara, CA 95051; tel.: 408-243-8143; fax: 408-243- 8544.*

CIRCLE NO. 26 ON FREE CARD

Windows & OS/2 Cursor Enhancement

CursorPower from North Shore Systems lets you redesign and re-size the arrow, hourglass, I-beam and other cursors that come standard with *Windows* 3.1 and OS/2 2.1. This program also lets you create new cursors from scratch and turn graphics and text into cursors. A special edition of *CursorPower* lets you enlarge the text insertion caret for *WordPerfect for Windows* documents. $49.95. *North Shore Systems, Inc., PO Box 8687, Incline Village, NV 89450; tel.: 702-831-1108; fax: 702-831-8553.*

CIRCLE NO. 27 ON FREE CARD

Periodic Table for *Windows*

The *Periodic Table for Windows* from Inner Access looks and feels like the wall-mount kind in a chemistry classroom, with its 109 chemical elements and titles. As you click on the hot spots over the titles, more information describing the titles in detail appears. When you select a particular element, the usual information appears, as does detailed information about its history, spectra, isotopes, compounds, physical properties, shells and crystalline structures. $49.95. *Inner Access Corp., PO Box 888, Belmont, CA 94002; tel.: 415-591-8295; fax: 415- 593-0542.*

CIRCLE NO. 28 ON FREE CARD

Resume Software for *Windows*

The *Easy Working Instant Resume for Windows* program from Spinnaker Software helps job seekers prepare professional-looking resumes. *Instant Resume* features several common resume templates to best match the user's experience with the most-appropriate type of resume format, including business, military, academic, recent graduate and others. $29.95. *Spinnaker Software, Inc., Cambridge, MA; tel.: 617-494-1200; fax: 617-494-0067.*

CIRCLE NO. 29 ON FREE CARD

Real-Estate Lawyer

Real Estate Lawyer is a legal software package from Z-Law Software that's designed to prepare custom real-estate documents for the non-lawyer. With this program, you can create 22 binding legal documents without having to hire an attorney. Included in the DOS program are sales contracts, residential and commercial leases, quitclaim and warranty deeds, mortgages, contractor agreements, lien releases and landlord and tenant letters. Each document is adaptable to a number of different legal situations. The forms are

Free Software

There appears to be a new trend in software distribution —giving it away free to a certain number of people. Whatever the reasoning behind this, you can end up a winner. One of the free software packages we've recently been made aware of is *Do-It-Yourself Accounting for Windows* from Central Computer Products. If you're among the first 100,000 respondents to call 1-800-FREE-WINACT (1-800-373-3946) to charge the modest $6.95 shipping-and-handling cost, this normally $69.95 package will be yours.

DIY Accounting is geared toward home offices and small businesses. This full-featured program is a complete double-entry accounting system that contains six popular modules, which include General Ledger, Checkbook Invoicing/Accounts Receivable, Inventory, Budgeting and Payroll. Other features include on-line help, unlimited data file capacity and data export to *dBASE*, Lotus *1-2-3*, ASCII and *Windows* Clipboard.

Do-It-Yourself Accounting for Windows requires *Windows* 3.0 or later, 2M of RAM and a 1.44M high-density 3½" floppy-disk drive. *Central Computer Products, 330 Central Ave., Fillmore, CA 93015; tel.: 1-800-373-3946; fax 805-524-4026.*

CIRCLE NO 30 ON FREE CARD

CD-ROM Bonanzas

Looking for a low-cost way to add to your CD-ROM library? If so, look into the offerings from John O'Connor Publishing. This company has a wide variety of CD-ROM titles from which to choose—at very reasonable prices. Two titles that drew our attention were *The Companion for Windows* and *999+ .WAV Files for Windows*, each selling for just $19.95. Both of these titles, as well as many others, contain collections of shareware software from Tropical Publishing and are well worth the modest price asked for them.

The Companion for Windows CD-ROM contains a total of 4,411 files that consist of .WAV sound files, graphics software, programming tools, multimedia modules, utility and font files. Included also is an assortment of desktop accessories, wallpaper utilities and software demonstration files. A DexWare™ file-handling and retrieval system is included for copying and using the files on the CD-ROM.

As its name implies, *999+ .WAV Files for Windows* (there are actually more than 1,500 .WAV files on the disk) consists of a collection of sound files ranging from sound effects to musical cues to quips from airwaves and a whole lot more. The files are in the *Windows* .WAV format for playing through a sound card. If you don't have a sound card, you can take advantage of the files with a driver utility included on the CD-ROM that routes the sound through your PC's built-in speaker. In addition to the .WAV files, this CD-ROM offers sound utilities that let you convert files from various formats into the *Windows* .WAV format and to record, play back and edit sound files. Another handy feature is a TidalWAV .WAV™ sound player that lets you audition the sound files. This utility displays the length of the currently loaded file and its filename and features a pushbutton interface that mimics the controls on a standard cassette or CD player.

At a price of only $19.95 per CD-ROM, you won't go wrong with these two (and other) titles in the John D. O'Connor catalog. *John D. O'Connor Publishing Ltd., 1601 S. Black Horse Pike, #5, Turnersville, NJ 08012-2021; tel.: 609-875-8897; fax: 609-875-6681.*

CIRCLE NO. 31 ON FREE CARD

claimed to be valid in all states, except Louisiana. $129.95. *Z-Law Software, Inc., PO Box 40602, Providence, RI 02940; tel.: 401-273-5588; fax: 401-421- 5334.*

CIRCLE NO. 32 ON FREE CARD

Windows Language & Typing Tutor

PC CompoNet's *Fingers for Windows* program on CD-ROM combines language education with a typing tutor. *The Fingers for Windows* Typing Class is a multimedia, multilingual typing tutorial. Users can start immediately learning typing skills from beginning through advanced levels in either English, Spanish or French. The Windows Keyboard replicates the exact keyboard layout used for that language.

The *Fingers for Windows* Language Class is a language tutorial that teaches correct pronunciation using digitized voices of native speakers. The Dual Teacher option links together the two disciplines. $99. *PC CompoNet, Inc., 1201 S. Beach Blvd., Ste. 204, La Habra, CA 90631; tel.: 310-943-9878; fax: 310-947-1131.*

CIRCLE NO. 33 ON FREE CARD

Upgrades

File-Manager Upgrade

NoVaSoft's CMFiler is a versatile disk/file manager for DOS. Version 5.36c adds 43- and 50-line VGA display capability. The program gives you a side-by-side split-screen display of two directories. You can copy and move files from one directory to the other, delete files, create new directories, change file and directory names and attributes and navigate levels of directory structures. A "tree" module lets you display whole disk structures side by side and copy, delete and move entire directories. Tree services also include a filename finder and fast text finder. Distributed as shareware, registration fee $30. *NoVaSoft, 3239 Riverview Dr., Triangle, VA 22172; tel.: 703-221-1833.*

CIRCLE NO. 34 ON FREE CARD

Shareware Libraries Update

EMS Professional Shareware has updated its *Small Business Assistant*, *HomePC Products* and *Best Games* libraries. Each library contains public-domain and shareware products selected especially for use in the home or small business. The libraries also feature a database directory and search system. All three libraries are available on one CD-ROM and individually on diskettes. $59.50/$79.50/$59.50, CD-ROM/*SBA* on disk/*HomePC* or *Games* on disk. *EMS Professional Shareware, 4505 Buckhurst Ct., Olney, MD 20832; tel.: 301-924-3594; fax: 301-963-2708.*

CIRCLE NO.35 ON FREE CARD

Interactive Panel Meter

Texmate's Model DI-50 meter measures ac/dc volts/current, platinum RTDs, all ISA and ANSI thermocouples and 4-to-20-mA process signals. Setup is via an IBM/compatible computer with interactive menu-driven software provided with the unit. Using millivolt dc-current shunts or 5-ampere CTs, this new meter can measure to 99,999 amperes dc or ac. The DI-50 offers three simultaneous outputs: dual 10-ampere setpoint relays, 4-to-20-mA and 0 to 5-volt dc analog signals, and RS-232/485 or BCD. To ensure that the outputs faithfully track the input, the meter performs concurrent slope integration at 60 readings per second.

Standard power is 85 to 264 volts ac at 47 to 440 Hz, with several optional adapters available. Up to 30 DI-50s can be strung on a serial bus (RS-485) to provide displays on a single computer screen. *Texmate, 995 Park Center Dr., Vista, CA 92083- 8397; tel.: 800-394-8344; fax: 619-598-9828.*

CIRCLE NO. 36 ON FREE CARD

By TJ Byers

PCMCIA: Panacea or Pandemonium?

Credit-card-sized PC peripherals stage to take on the PC world by storm. Here's what they promise—and what they do.

If you're in the market for a notebook computer, you've no doubt heard or read about an option called PCMCIA and have been wondering about what it is and whether or not you need it. In this article I'll try to answer all your questions regarding PCMCIA as it exists at the present time. By the time you finish reading this article and Joe Desposito's accompanying piece you'll be an expert in PCMCIA terms.

PCMCIA Defined

Simply put, PCMCIA (Personal Computer Memory Card International Association) is a set of specifications for an expansion port that lets you add peripherals—such as memory, CD-ROM and modems—to a notebook PC in the same way you'd add similar devices to your desktop PC. That is, you simply plug these items into a slot. The PCMCIA slot lets you freely swap credit-card-size devices in and out of your notebook PC, changing functions and features in an instant. (See Table 1 for pinout details for the PCMCIA-card standard.) PCMCIA's plug-and-play capability makes all this possible. Thus, with just one slot, you can effortlessly customize your PC for changing applications on-the-fly. For example, you can remove a modem card and replace it with an Ethernet card for 10Base-T communications or plug in an SCSI card to gain access to a CD-ROM drive.

PCMCIA's plug-and-play tech-

PCMCIA cards pack a lot into very limited real estate. Each card begins as a printed-circuit assembly with surface-mounted components soldered into place. This assembly is housed in a standard credit-card-sized case, at one or both ends of which are connectors. In the case of memory cards, like the (A) DRAM and (B) Flash memory cards and, there's a PCMCIA connector on only one end of the card. This plugs into the PCMCIA slot on the computer with which it's used. In addition, the Flash memory card has at the end opposite the connector a slide-type write-protect switch that can be user-enabled/disabled.

(Photos courtesy of Amp. Inc.)

Table 1. PCMCIA Expansion- Slot Pinout Details

16-Bit PCMCIA Expansion Slot Memory-Only Interface

(68-Pin Dual-In-Line Connector)

Pin	I/O	Signal	Description
1	—	GND	Ground
2	I/O	D3	Data Bit 3
3	I/O	D4	Data Bit 4
4	I/O	D5	Data Bit 5
5	I/O	D6	Data Bit 6
6	I/O	D7	Data Bit 7
7	O	CE1	Card Enable 1
8	I/O	A10	Address Bit 10
9	O	OE	Output Enable
10	I/O	A10	Address Bit 11
11	I/O	A9	Address Bit 9
12	I/O	A8	Address Bit 8
13	I/O	A13	Address Bit 13
14	I/O	A14	Address Bit 14
15	I/O	WE/PGM	Write Enable/Program
16	I/O	RDY/BSY	Card Ready
17	O	Vcc	Power Supply
18	—	Vpp1	Progamming Supply Voltage 1
19	I/O	A16	Address Bit 16
20	I/O	A15	Address Bit 15
21	I/O	A12	Address Bit 12
22	I/O	A7	Address Bit 7
23	I/O	A6	Address Bit 6
24	I/O	A5	Address Bit 5
25	I/O	A4	Address Bit 4
26	I/O	A3	Address Bit 3
27	I/O	A2	Address Bit 2
28	I/O	A1	Address Bit 1
29	I/O	A0	Address Bit 0
30	I/O	D0	Data Bit 0
31	I/O	D1	Data Bit 1
32	I/O	D2	Data Bit 2
33	O	WP	Write Protect
34	—	GND	Ground
35	—	GND	Ground
36	I	D1	Card Detect 1
37	I/O	D11	Data Bit 11
38	I/O	D12	Data Bit 12
39	I/O	D13	Data Bit 13
40	I/O	D14	Data Bit 14
41	I/O	D15	Data Bit 15
42	O	CE2	Card Enable 2
43	O	RFSH	Refresh
44	—	NA	Reserved
45	—	NA	Reserved
46	I/O	A17	Address Bit 17
47	I/O	A18	Address Bit 18
48	I/O	A19	Address Bit 19
49	I/O	A20	Address Bit 20
50	I/O	A21	Address Bit 21
51	O	Vcc	Power Supply
52	O	Vpp2	Progamming Supply Voltage 2
53	I/O	A22	Address Bit 22
54	I/O	A23	Address Bit 23
55	I/O	A24	Address Bit 24
56	I/O	A25	Address Bit 25
57	—	NA	Reserved
58	I	RESET	Reset
59	I	WAIT	Wait
60	—	NA	Reserved
61	O	REG	Register Select
62	I	BVD2	Battery Voltage Detect 2
63	—	BVD1	Battery Voltage Detecr 1
64	I/O	D8	Data Bit 8
65	I/O	D9	Data Bit 9
66	I/O	D10	Data Bit 10
67	I	CD2	Card Detect 2
68	—	GND	Ground

16-Bit PCMCIA Expansion Slot I/O and Memory Interface

(68-Pin Dual-In-Line Connector)

Pin	I/O	Signal	Description
1	—	GND	Ground
2	I/O	D3	Data Bit 3
3	I/O	D4	Data Bit 4
4	I/O	D5	Data Bit 5
5	I/O	D6	Data Bit 6
6	I/O	D7	Data Bit 7
7	O	CE1	Card Enable 1
8	I/O	A10	Address Bit 10
9	O	OE	Output Enable
10	I/O	A10	Address Bit 11
11	I/O	A9	Address Bit 9
12	I/O	A8	Address Bit 8
13	I/O	A13	Address Bit 13
14	I/O	A14	Address Bit 14
15	I/O	WE/PGM	Write Enable/Progam
16	O	IREQ	Interrupt Request
17	O	Vcc	Power Supply
18	O	Vpp1	Programming and Peripheral Supply 1
19	I/O	A16	Address Bit 16
20	I/O	A15	Address Bit 15
21	I/O	A12	Address Bit 12
22	I/O	A7	Address Bit 7
23	I/O	A6	Address Bit 6
24	I/O	A5	Address Bit 5
25	I/O	A4	Address Bit 4
26	I/O	A3	Address Bit 3
27	I/O	A2	Address Bit 2
28	I/O	A1	Address Bit 1
29	I/O	A0	Address Bit 0
30	I/O	D0	Data Bit 0
31	I/O	D1	Data Bit 1
32	I/O	D2	Data Bit 2
33	O	IOIS16	I/O Port is 16 Bits
34	—	GND	Ground
35	—	GND	Ground
36	I	CD1	Card Detect 1
37	I/O	D11	Data Bit 11
38	I/O	D12	Data Bit 12
39	I/O	D13	Data Bit 13
40	I/O	D14	Data Bit 14
41	I/O	D15	Data Bit 15
42	O	CE2	Card Enable 2
43	O	RFSH	Refresh
44	I/O	IORD	I/O Read
45	I/O	IOWR	I/O Write
46	I/O	A17	Address Bit 17
47	I/O	A18	Address Bit 18
48	I/O	A19	Address Bit 19
49	I/O	A20	Address Bit 20
50	I/O	A21	Address Bit 21
51	O	Vcc	Power Supply
52	O	Vpp2	Programming and Peripheral Supply 2
53	I/O	A22	Address Bit 22
54	I/O	A23	Address Bit 23
55	I/O	A24	Address Bit 24
56	I/O	A25	Address Bit 25
57	—	NA	Reserved
58	I	RESET	Reset
59	I	WAIT	Wait
60	O	INPACK	Input Port Acknowlede
61	I/O	REG	Register Select & I/O Eenable
62	O	SPKR	Audio Digital Waveform
63	I	STSCHG	Card Status Changed
64	I/O	D8	Data Bit 8
65	I/O	D9	Data Bit 9
66	I/O	D10	Data Bit 10
67	I	CD2	Card Detect 2
68	—	GND	Ground

Table 2. PCMCIA Storage-Card Buying Guide

Manufacturer	Model	Technology*	Capacity
Conner Peripherals	CP-1034	Hard Disk	30M
Integral	PocketFile 40	Hard Disk	40M
	PocketFile 85	Hard Disk	85M
	1841PA	Hard Disk	40M
	1862PA	Hard Disk	62M
Ministor	MP64P	Hard Disk	64M
Maxtor	MXL 105-11	Hard Disk	105M
Seagate	ST72P	Solid State	2.5M
	ST75P	Solid State	5M
	ST710P	Solid State	10M
	ST714P	Solid State	15M
	ST20P	Solid State	20M
	ST72P5	Solid State	2.5M
	ST75P5	Solid State	5M
	ST710P5	Solid State	10M
SunDisk	SDP-2.5	Solid State	2.5M
	SDP2.5	Solid State	5M
	SDP-10	Solid State	10M
	SDP-15	Solid State	15M
	SDP-20	Solid State	20M
	SDPL5-2.5	Solid State	2.5M
	SDPL5-5	Solid State	5M
	SDPL5-10	Solid State	10M
Western Digital	PB 140	Hard Disk	40M
AMD	C001FLKA	Flash	1M
	C002FLKA	Flash	2M
	C004FLKA	Flash	4M
AMP	797080-1	SRAM	256K
	797080-2	SRAM	512K
	797080-3	SRAM	1M
	797080-4	SRAM	2M
	797078-1	Flash	512K
	797078-2	Flash	1M
	797078-3	Flash	2M
	797078-5	Flash	4M
AMD	C001FLKA	Flash	1M
	C002FLKA	Flash	2M
	C004FLKA	Flash	4M
ASCII	SG512-S	SRAM	512K
Century	CSR1000	SRAM	1M
	CSR128	SRAM	128K
	CSR2000	SRAM	2M
	CSR256	SRAM	256K
	CSR512	SRAM	512K
Dupont	100504	SRAM	256K
	90100505	SRAM	512K
	90100507	SRAM	1M
	9010059	SRAM	2M
	Flash1M	Flash	1M
	Flash2M	Flash	2M
Epson	A065SD20	SRAM	64K
	A129SD20	SRAM	128K
	A257SD20	SRAM	256K
	A513SD20	SRAM	512K
	A101SD20	SRAM	1M
	A201SD20	SRAM	2M
	B257SDX0	OTP	256K
	B513SDX0	OTP	512K
	B101SDX0	OTP	1M
	B201SDX0	OTP	2M
	H101SDX0	Flash	1M
	H201SDX0	Flash	2M
	H257SDX0	Flash	256K
	H135SDX0	Flash	512K
	L065DS20	SRAM	64K
	L129SD20	SRAM	128K
	L201SD20	SRAM	2M
	L257SD20	SRAM	256K
	L513SD20	SRAM	512K
	0101SDX0	OTP	1M
	0257SDX0	OTP	256K
	0513SDX0	OTP	512K
	0201SDX0	OTP	2M
FDK	SC9001	SRAM	512K
	SC9008	Flash	1M
	SC9011-H	OTP	1M
	SC9011-P	OTP	2M
Fujisoku	JS64G3	SRAM	64K
	JS128G3	SRAM	128K
	JS256G3	SRAM	256K
	JS512G3	SRAM	512K
	JS1024G3	SRAM	1M
Fujitsu	60813	OTP	256K
	608A2	EPROM	256K
	60913	OTP	512K
	609A2	EPROM	512K
	61013	OTP	1M
	610A2	EPROM	1M
	61113	EPROM	2M
	90603	SRAM	64K
	90703	SRAM	128K
	90803	SRAM	256K
	90903	SRAM	512K
	91023	SRAM	1M
	91123	SRAM	2M
Hewlett Packard	F1002A	SRAM	128K
	F1003A	SRAM	512K
Intel	IMC001	Flash	1M
	IMC002	Flash	2M
	IMC004	Flash	4M
	IMC01S2	Flash	10M
	IMC020S2	Flash	20M
ITT	0.0152	SRAM	512K
MACRO	415F-3	Flash	1M
	451S-1	SRAM	64K
	451S-2	SRAM	128K
	451S-3	SRAM	256K
	451S-4	SRAM	512K
	451S-5	SRAM	1M
	451S-6	SRAM	2M
Mitsubiahi	MF3129	SRAM	128K
	MF31M1	SRAM	1M
	MF3257	SRAM	256K
	MF3513	SRAM	512K
Panasonic	BN064HMC	SRAM	64K
	BN128HMC	SRAM	128K
	BN256HMC	SRAM	256K
	BN512HMC	SRAM	512K
	BN01MHMC	SRAM	1M
	BN02MHMC	SRAM	2M
	BN04MHMC	SRAM	4M
Poqet	SC9001	SRAM	512K
	SC9008	Flash	1M
	SC9011-H	OTP	1M
	SC9011-P	OTP	2M
Pretec	JA0512S	SRAM	512K
	JA2048S	SRAM	2M
Smart	SM9FL2M	Flash	2M
Sumitomo	256FJ-NA	Flash	256K
	512FJ-NA	Flash	512K
	01MFJ-NA	Flash	1M
	02MFJ-NA	Flash	2M
	04MFJ-NA	Flash	4M
Texas Instruments	P68F1MBN	Flash	1M

* Hard Disk is a traditional rotating-platter electromechanical drive; Solid-State is a non-mechanical "disk" drive (RAM that keeps its contents as a result of the device's own built-in battery); SRAM is static random-access memory; EPROM is erasable programmable read-only memory; OTP is one-time-programmable read-only memory.

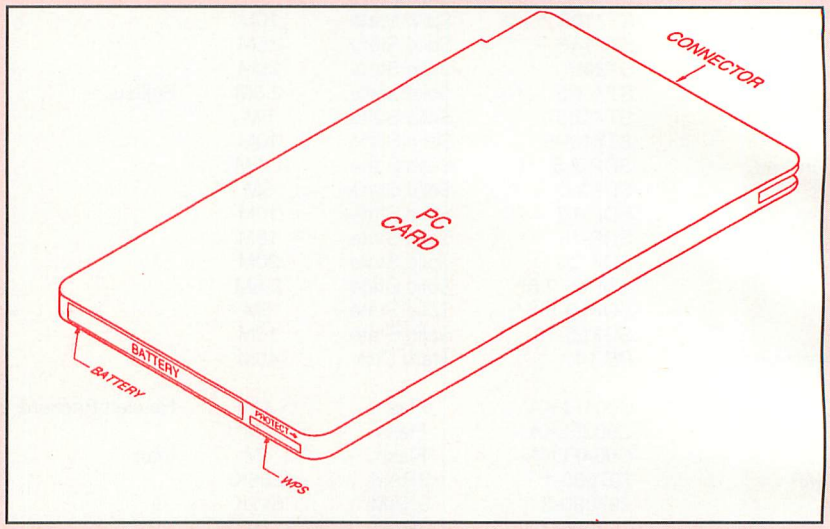
By Joe Desposito

PCMCIA: The Mouse that Roared

Defining a new standard in portable computers—and almost certainly in desktop PCs

A standard called "PCMCIA" has exploded upon the microcomputer scene during the past year. Like the famous gunslinger, Paladin, you know PCMCIA by its card. A PCMCIA card is about the size of a standard credit card. It typically fits into a special PCMCIA slot on notebooks, sub-notebooks and other computers. PCMCIA is building up such a head of steam that it threatens to blow away everything, from mechanical disk drives to those wonderful expansion slots on PC motherboards.

PCMCIA isn't only a technical design standard. It's also the acronym for a nonprofit trade association and standards body known as the Personal Computer Memory Card International Association. Established in 1989 and headquartered in Sunnyvale, CA, the Association is com-



nology also lends itself well to hassle-free data exchange. Traditionally, data is stored on a hard disk or other non-removable storage medium. The drawback of this technique is moving your data between PCs. PCMCIA alleviates this problem by letting you move a memory or hard-disk card from one PC to another. This means you could take your data—as well as customized DOS and *Windows* operating systems —with you anywhere you go: to work, to home, to school or abroad. At your destination, you simply plug the PCMCIA device into a PCMCIA slot, and you're back in business.

While the concept of media exchange isn't new and is supported by several devices, such as the Bernolli Box, you don't need special hardware to pull off this feat of legerdemain. Because PCMCIA is universally supported, all you need is an available PCMCIA slot. Moreover, PCMCIA lets you perform live installation and removal of PC cards, which means that you don't even have to power down the system.

While the types of available PCMCIA devices aren't as plentiful as those for the AT and EISA slots at the present time, they cover a good range of functions and will certainly cover more in the not-too-distant future. Here's a look at what's currently on the market.

Storage Devices

Undoubtedly, storage devices are the most popular of all PCMCIA cards, basically because they let you expand the limited resources that are often characteristic of notebook computers. PCMCIA storage devices employ five different technologies to preserve your precious data. These include programmable ROM, Flash memory, SRAM, solid-state hard-disk emulators and traditional electromechanical rotating-platter hard-disk media.

• ***Programmable ROM.*** The least-sophisticated of PCMCIA storage devices are programmable ROMs that behave exactly like the BIOS ROM used to control your PC. Basically, these consist of a matrix of memory cells that store data indefinitely without need for a power source. All programming is performed in a single session, whether or not all cells are used. Programmable-ROM PCMCIA cards range in capacity from 256K to 2M and are generally used to store applications for customized boot and quick access. For example, you may have one card that contains Lotus *1-2-3* and another that holds *WordPerfect*, both of which may be bootable.

To re-program a programmable-ROM card, all data must be erased in bulk. Several proprietary schemes exist for erasing the data, but all use an electrical signal of some kind to clear the ROM of data. Table 2 lists the different erasure methods used. (It includes the acronyms OTP, OTPROM and EPROM that describe the type of memory devices.)

Once erased, the card can be programmed with new data. Of course, all this is transparent to you, the user. Since PCMCIA drivers take care of the details, all you ever see is the shift from old data to new data. But all this erasing and writing takes time—a lot more time than with other solid-state PCMCIA storage technologies—and you can do it only so many times. After about 10,000 erasures, the medium wears out.

• ***Flash Memory.*** Flash cards are the

prised of more than 350 member companies that define the industry-standard PC Card technology. These companies range from computer manufacturers like IBM, Apple and Toshiba to consumer-electronics companies like Kodak and Polaroid. PCMCIA promotes inter-operability among PC Cards and PC Card-based systems. These systems or host machines can encompass any computer-based device, including notebooks, palmtops, personal communicators, laser printers, digital cameras, electronic book players and test equipment.

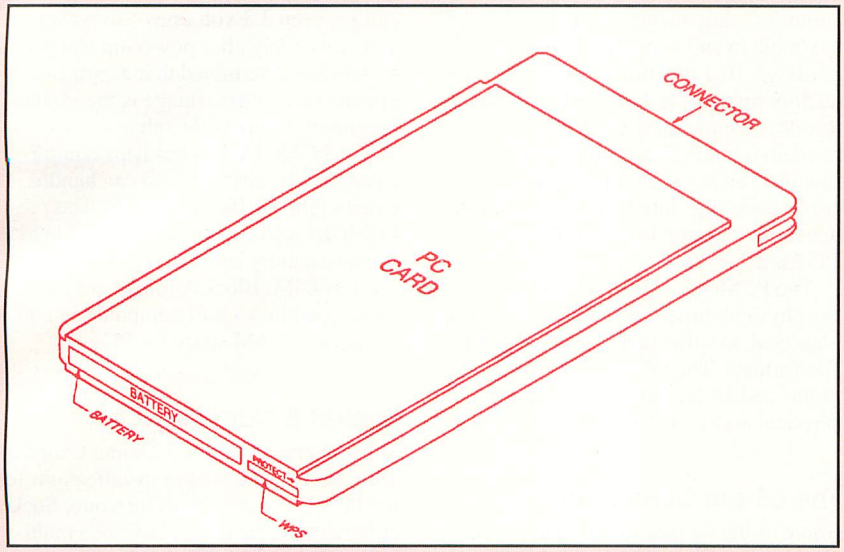


Fig. A. Physical details of Type I (opposite page) and Type II PCMCIA PC Cards as defined by Release 2.01 of the PCMCIA PC Card standard.

PCMCIA has undergone three releases to date. Issued in September 1990, Release 1.0 fully defined issues relating to handling memory cards used as data-storage devices. Release 2.0, issued in September 1991, broadened the specification with the addition of input/output and execute in place (XIP) capabilities, allowing for mass storage, modem, LAN, cellular and radio-frequency communication peripherals. Other key features of Revision 2.0 include hot swapping and support for dual-voltage memory cards. Release 2.01 is the typographical correction of Release 2.0. All PCMCIA standards are completely backward-compatible.

PCMCIA adopted the existing 68-pin credit-card form factor defined in 1985 by JEIDA (Japanese Electronic Industry Development Association). PCMCIA refined this physical specification and added definitions for pin assignments, electrical characteristics, protocols and file formats. PCMCIA standard Release 2.0 corresponds to JEIDA 4.1. PCMCIA has also worked closely with other international standard-setting bodies, including EIA/ EDEC (Electronics Industry Association/ Joint Electron Device Engineer Council) and ISO (International Standards Organization).

least-expensive form of PCMCIA storage. They also have a very high storage-to-capacity ratio and can comfortably store 20M in a Type I (3.3-mm) PCMCIA package. Flash technology is a lot like programmable ROM, but it's faster. Data is permanently stored in memory cells that need no power to retain it once it's written. Storage capacity ranges from 256K to 20M and costs about $100 for 2M.

Typically, Flash memory is used for read-only memory (ROM) applications, the same as programmable ROM storage. Flash cards must be formatted using a special FAT (File Allocation Table) utility made exclusively for Flash RAM. While new files can be added without problem, individual files can't be deleted. Generally, the card has to be bulk-erased, forcing you to copy files you wish to save to your hard disk and back again after the Flash card has been erased and formatted.

Fortunately, there's an alternative to the above. Microsoft's Flash File System Version 2.0 (FFS2) is a special-purpose formatting scheme that organizes data on a Flash card in a novel way, allowing you to use a Flash card in the same way you'd use a floppy disk. FFS2 provides the most-flexible structure for Flash cards, and it works with all DOS commands, except FORMAT and CHKDSK. Furthermore, you can't boot from an FFS2-formatted card. Therefore, it's sometimes convenient to split Flash memory into two partitions (logical drives). The first partition is formatted for the Flash FAT system, the second for the FFS2 system. With this arrangement, you can easily copy files between the two logical drives using the DOS COPY command while retaining the ability to boot from the card. But like programmable ROM, Flash memory has a life span of 10,000 cycles or thereabouts.

• ***SRAM.*** The fastest of the PCMCIA storage devices uses static-RAM (SRAM) memory chips. These chips are very fast, with an access time of 25 ns or less, and are identical to the memory chips used for CPU memory caching in desktop and notebook PCs. For comparison, the dynamic-RAM (DRAM) memory chips used for a PC's main memory have speeds of 70 to 100 ns, Flash memory has an access time of about 250 ns and programmable ROM is about 300 ns.

Although faster than programmable ROM and Flash memory, SRAM is more costly, occupies more space and requires a power source at all times to retain data stored in it. This means that the card must have its own battery. The dime-sized 3-volt lithium battery is the same as that used in many calculators and clocks. Battery life is about a year. Because of its high cost, the capacity of SRAM memory cards starts at a paltry 64K and tops out at 4M. A 1M SRAM card typically costs $150.

Before you use it, you must initialize an SRAM card with a special PCMCIA formatting utility, much as you would format a floppy or hard disk before being able to use it. Once you've formatted the card, you can use it as you would a floppy diskette. It works with all DOS commands and applications to read and write data from and to the card. Unlike Flash memory, however, SRAM doesn't wear out. You can read from and write to it forever—at least for as long the battery lasts.

• ***Hard Disk.*** The two major classes of

The PC Card

A PC Card is a peripheral that adds such capabilities to computers as memory, mass storage, LAN, fax/modem and wireless communication. The PC Card is roughly the dimensions of a standard credit card, measuring 2.126" x 3.37". It has a standardized 68-pin connector at one end. The pinouts for this connector are listed in Table 1 of the main article. The primary benefits of the PC Card are its low power consumption, small size and ruggedness. PC Cards can be used with any personal portable computer system that's equipped with a PCMCIA slot.

PC Cards plug into sockets on a host system, such as a notebook computer. Host systems can have one or more sockets that may be grouped together on one or more adapters. An example of a host system that has more than one adapter would be one in which an adapter is built into the motherboard and another is plugged into the system's expansion bus.

PCMCIA has defined three PC Card types: Type I, Type II and Type III (Fig. A). All three card types are the same length and width and are 3.3 mm thick along their guide rails and connector ends so that they can be plugged into standard PCMCIA slots. Type I cards are a constant 3.3 mm thick and are typically used for various types of memory enhancements, including RAM, Flash memory, one-time programmable (OTP) memory and electrically-erasable programmable read-only memory (EEPROM). Type II cards are 5 mm thick to accommodate applications that require slightly more room for components, such as fax/modem and network cards. Type III cards are 10.5 mm thick to accommodate such peripherals as hard-disk drives and wireless communication devices. To give users maximum flexibility, computer manufacturers can build double- or triple-deck slots into their computers to accommodate combinations of the three PC Card types.

The PCMCIA PC Card standard covers physical dimensions, pin assignments, electrical specifications, protocols and file formats. The PC Card interfaces with eight- and 16-bit buses and supports physical access up to 64M of memory.

The 68-pin Connector

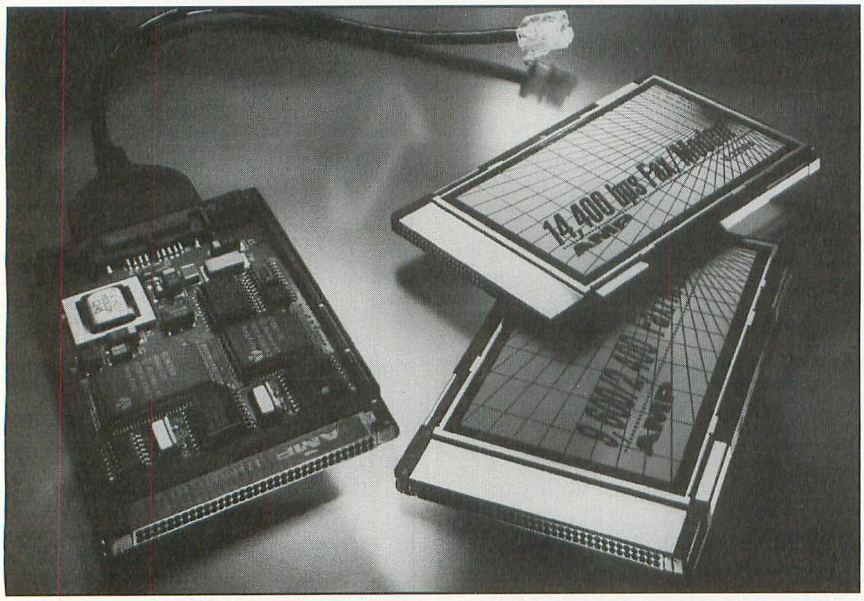
Some of the 68 pins of a PCMCIA interface have different meanings for memory cards and I/O cards. Not even power connections are straightforward for PCMCIA. Of a PCMCIA connector's 68 pins, two are for V_{cc} (+5 volts) and two are for V_{pp}. For memory cards, V_{pp} is a programming voltage, and for I/O cards, it can be an additional operating voltage. Cards that operate on 3.3 volts, for example, connect to a 3.3-volt supply via a V_{pp} pin.

The PCMCIA specification requires all cards—even 3.3-volt ones—to power up at 5 volts. Only after power-up and the system has determined that a card can operate on another voltage is the system permitted to supply the other voltage.

The PCMCIA data bus isn't complicated. It's 16 bits wide and can handle either eight- or 16-bit transfers. The PCMCIA address bus is 26 bits wide to permit memory cards with capacities as great as 64M. Blocks of this 64M must be mapped into a host computer's memory space—a 16M space for PCs.

Socket & Card Services

Socket Services Release 2.0 and Card Services Release 2.0 are the specifications for the PCMCIA software architecture. Socket Services is the lowest layer in a multilayer architecture that manages resources on PCMCIA-compatible memory and I/O cards. Immediately above Socket Services



PCMCIA fax/modems give PCs equipped with PCMCIA slots a convenient means for effecting communication with other computers, BBSes and other online services. This type of card has a compact connector that accommodates the communication cable that plugs into the telephone line on the end opposite the PCMCIA connector. (Photo courtesy of Amp Inc.)

PCMCIA hard-disk devices are solid-state cards and traditional electromechanical rotating-platter disks. Both "talk" to the PCs in which they're installed via an ATA (AT Attachment) interface. The ATA interface is electrically identical to the very-popular IDE drive interface used to connect hard drives to desktop PCs.

There are two versions of the ATA interface. The first-generation ATA interface made it possible for 1.3" and 1.8" hard-disk drives to work in the PCMCIA form factor. Although the interface isn't PCMCIA-compatible, it's supported by most PCMCIA software, such as *CardTalk*. It wasn't until last year that a PCMCIA version of the ATA interface was finalized. Except for possible markings, PCMCIA ATA drives are physically indistinguishable from first-generation ATA drives.

The PCMCIA ATA standard is largely the result of early efforts by SunDisk to interface its solid-state hard disks to the PC via the PCMCIA slot. In fact, SunDisk is the largest manufacturer of solid-state PCMCIA hard disks and OEM supplier for names like Hewlett Packard and others. Disk capacity ranges from 2.5M up to 20M, and the form factor is a trim 5-mm Type II. In some circles, the SunDisk card is referred to as a Flash card when, in fact, it's not.

Flash card utilities won't work with ATA solid-state drives. While it takes a special utility to initialize the solid-state drive, once the drive is partitioned it behaves just like a rotating-platter hard disk. It then accepts all

is Card Services, which arbitrates use of Socket Services resources.

Socket Services provides a universal (BIOS-level) software interface to the hardware that controls sockets for PC Cards. It isolates other software from the underlying hardware. Socket Services identifies how many sockets are in a computer system and detects insertion and removal of a PC Card while the system is powered up. Device drivers written for specific I/O cards run on any system that supports Socket Services.

Socket Services connect a PCMCIA host controller, such as the Intel 82365SL, to higher services like Card Services and device drivers. Different host controllers may require different Socket Services but not different Card Services or device drivers. BIOS writers—such as Phoenix, AMI, SystemSoft and Award—are currently working to incorporate Socket Services into BIOSes designed to support PCMCIA-compatible notebooks.

Card Services is a software-management interface that automatically allocates system resources, such as memory and interrupts, once Socket Services detects that a PC Card has been plugged in. Card Services releases these resources when the PC Card has been unplugged from the slot. Card Services also provides an interface to higher-level software to load any needed hardware drivers and applications that access the PC Cards.

Card Services sits between Socket Services and device drivers of applications. If a notebook or other computer doesn't include support for Card Services in its BIOS, the PC Card manufacturer must supply software that connects drivers to Socket Services or directly to the PCMCIA host controller. This isn't a major issue for end users. It simply adds to the engineering burden of card manufacturers.

Card Services has two goals. One is support of the ability of PCMCIA-aware device drivers, configuration utilities and application programs to share PC Cards, sockets and system resources. The other is to provide a centralized resource for the common functionality required by these drivers, utilities and applications.

The Card Services interface is structured in a client/server model. Application programs, device drivers and utility programs are the clients that request services. A Card Services implementation is the server that provides the functions requested by clients (Fig. B).

With completion of Card Services and Socket Services standards, inter-operability, as far as PCMCIA is concerned, is guaranteed among systems that follow the specifications. It's the primary goal of PCMCIA to ensure full compatibility.

PCMCIA Memory Cards

Each PCMCIA memory card installed in a system has a separate memory address space of 64M. Common Memory can be accessed by a host system for memory read and write operations. Direct memory access (DMA) read and write operations to Common Memory are possible when this memory is mapped directly into a DMA controller's address space.

There's an additional 64M address space for Attribute Memory, which is selected by the –REG signal in the interface. This memory space can be divided into areas for: Card Information Structure (CIS), which is a description of the card's capabilities, specifications and use; configuration registers, which are an optional set of registers that permit the card to be configured by the system; and a reserved area, which is a portion of Attribute Memory that has yet to be specified.

Size of each of these areas is determined by the card vendor. The Card In-

DOS and application commands, including FORMAT and CHKDSK. The cost of a 20M SunDisk averages about $1,000.

Interestingly, the 20M SunDisk is, in reality, a 10M disk that uses *Stacker* data compression to double its storage capacity. As such, it's not a true 20M hard disk. Because the data is compressed, actual disk size depends on the type of data being handled. If you're storing text, which generally compresses 2:1, you get 20M of storage space. Graphics files generally fare better. For example, .PCX graphics files can be compressed 3:1, effectively giving you 30M of disk space. Already-compressed files, on the other hand, have less than 20M of available space. For example, if you were to move the *Windows for Workgroups* files from floppy disks to a 20M SunDisk, they won't all fit. Since these files are already compressed and total 12M, they can't all fit into the 10M of solid-state memory.

PCMCIA rotating-platter hard-disk drives are simply miniature versions of their desktop counterparts. Shoehorning a rotating platter into a PCMCIA form factor is no easy trick. The largest platter you can fit into a PCMCIA case is 1.8", and this is really pushing it. Most platters measure 1.3" across. Height is the second limitation. Though a single platter will fit in a Type II case, it won't give you much in terms of storage capacity. For capacity beyond 40M, you need to stack at least two platters, which expands the form factor to Type III (10.5 mm) or thicker. In fact, Integral's PocketFile 85 drive (85M) measures 12.5 mm thick and won't fit in all Type III slots. Maxtor, maker of the 105-MB MobileMax, is working on a three-platter drive that uses 1.8" platters that the company says will eventually have a capacity of 440M. Not surprisingly, rotating PCMCIA drives are less expensive than their solid-state counterparts. You can buy 100M for about $600.

Modems

It's difficult to imagine any PC, whether notebook or desktop, that doesn't have a modem for communication, which is why PCMCIA modems are very popular items. In fact, most notebooks with PCMCIA slots don't have a built-in modem because the PCMCIA slot offers greater flexibility, allowing you to upgrade your modem as your communication needs change.

Most PCMCIA modems sold today run at 14.4K or 9,600 bps (bits per second) and come in a Type II form factor. Prices average $300 to $350. If this is too steep for your budget, you can buy a 2,400-bps modem for about $225. Virtually all PCMCIA modems come with built-in 9,600-bps fax capabilities at no extra cost. The phone line usually interfaces to the fax/modem card via a pigtail that plugs into the outside edge of the card. A few cards mold the pigtail into the fax/modem's case, and at least one, Megaherts's Fax Modem with X-Jack, lets you plug an RJ-11 phone plug directly into the fax/modem card. (See Table 3 for a sampler listing of available PCMCIA modems.)

A common problem with PCMCIA fax/modem cards is interrupt sharing. While sharing interrupts works well under *Windows*, it causes some DOS applications, like *Kermit*, to malfunction when they're run under DOS. The solution is to make sure the fax/modem card you choose comes with

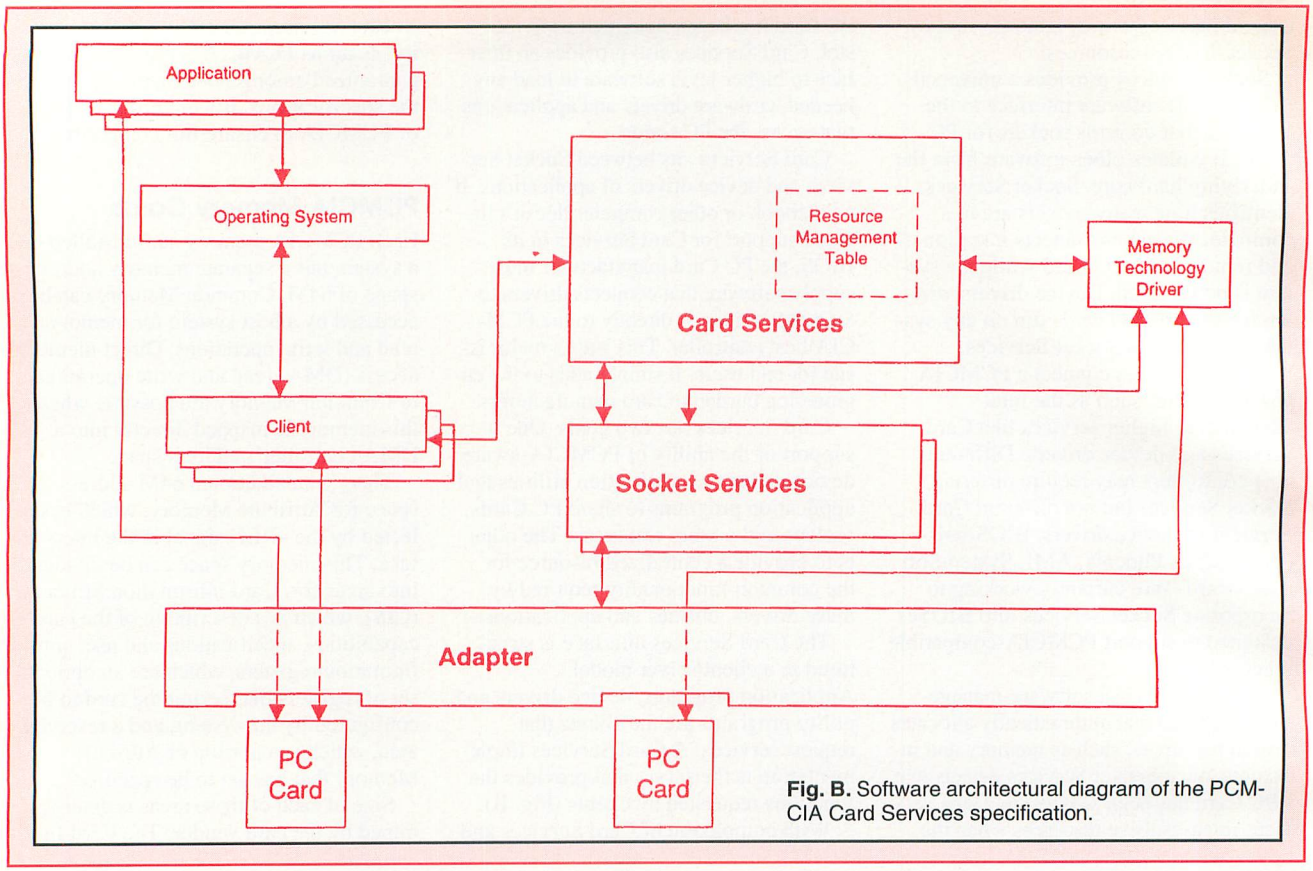
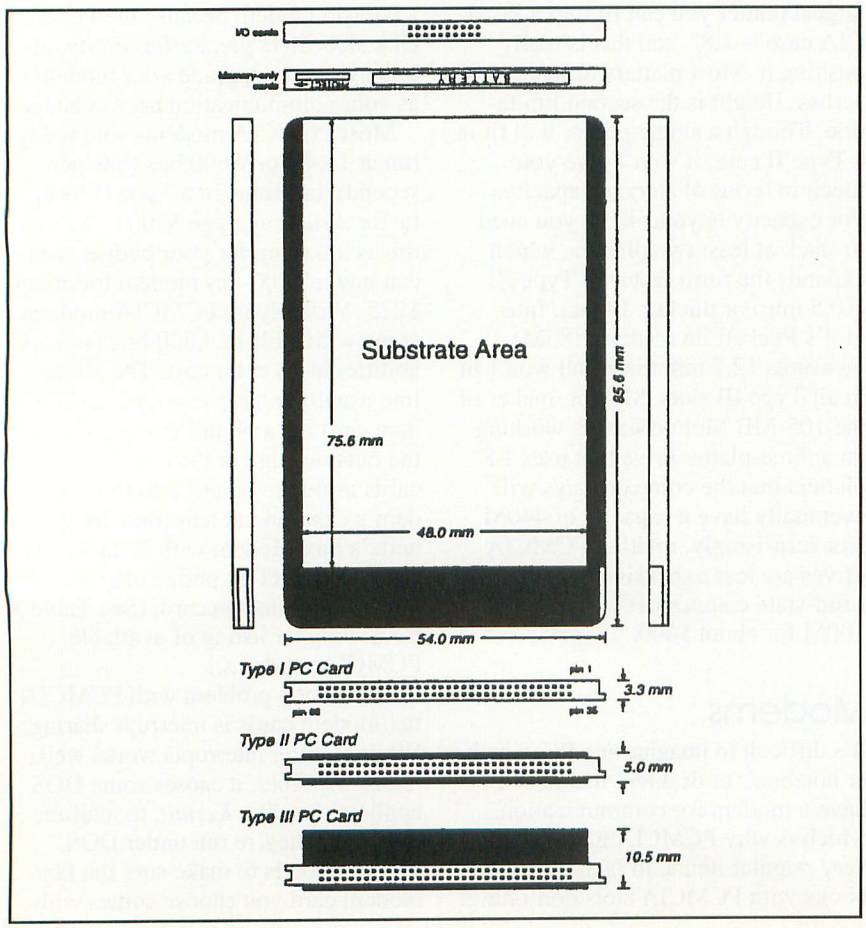


Fig. B. Software architectural diagram of the PCMCIA Card Services specification.



This drawing shows the physical details and dimensions for Type I through Type III PCMCIA PC Cards
(Courtesy of MicroDesign Resources)

software that supports COM3 and COM4 ports to avoid such conflicts.

Network Cards

Like modem cards, PCMCIA network cards are becoming very popular. Network cards are convenient for temporarily incorporating a notebook computer into an existing computer network. The same network card can be shared with desktop PCs that have PCMCIA support, which gives the casual network user a substantial cost advantage and saves an ISA bus slot.

While there are a couple PCMCIA network cards made for the Arcnet and Token Ring networks, nearly all PCMCIA network cards are of the Ethernet variety. Like fax/modem cards, the PCMCIA network card interfaces to the network via a pigtail that plugs into the card or is molded in its case. Usually, the card can be configured for either the 10Base-T, RJ-45 interface or the 10Base2 "cheapernet" BNC interface. The cheapernet

formation Structure must begin at address 0 but need not be a single contiguous region.

The Memory-Only Interface supports memory cards, but it doesn't contain signals that support I/O cards. The signals +RDY/–BSY, WP, BVD1 and BVD2 are present on the Memory-Only Interface but are replaced by other signals when the I/O Interface is selected. Cards and systems designed to PCMCIA PC Card Standard Release 1.0 don't support RESET and –WAIT signals.

The Memory-Only Interface is the default selected in both the socket and the card whenever a card is plugged into a socket and immediately following application of V_{cc} or the RESET signal to the card. Implementation of this interface is required in all Release 2-compliant systems.

After a card's Card Information Structure had been interpreted, card and socket can be configured, if appropriate, to use the I/O Interface.

PCMCIA I/O Cards

The hardware interface supports a single I/O address space of 64M for peripheral device access. The I/O address space is shared and divided among all cards installed in the system. However, many system architectures (such as the 80x86 architectures found in many PCs) support only a 64K I/O address space.

The I/O Interface supports the following signals, some of which replace Memory-Only signals that aren't supported in the I/O interface: Interrupt Request (–IREQ), I/O Port is 16 bits (–IOIS16), I/O Read Strobe (–IORD), I/O Write strobe (–IOWR), Input Port Acknowledge (–INPACK), audio digital waveform intended for a speaker (–SPKR) and a card Status Changed (–STSCHG) signal.

Peripheral cards must be configured by the system before their I/O Interfaces become active. Before configuring a card, the system must examine the card's Card Information Structure to determine the I/O address space and interrupt request and other requirements of the possible card configurations.

PCMCIA I/O cards aren't hard-wired to a particular I/O space. Instead, they have the flexibility to connect dynamically to different locations. For PCs, the connection is in the first 64K of I/O address space.

Similarly, PCMCIA cards don't have hard-wired interrupts. A PCMCIA interface must be able to steer a card's interrupt to any of several system-bus interrupts. These and other requirements of the PCMCIA specification put quite a few demands on a PCMCIA host system and the system's card-slot interface. In many cases, the system and interface will also need to provide power management—not only for PCMCIA cards, but also for the interface circuit itself.

Execute in Place

The PCMCIA standard permits operating-system and applications software to execute in place, or XIP, from ROM or flash memory on the PC Card. This contrasts with traditional approaches that must first load programs into RAM. Thus, the standard reduces the need for large amounts of RAM. XIP is intended primarily for use with ROM cards, but it can work from any card technology.

Two types of XIP support are defined. LXIP refers to applications structured to operate in a 16K paged-execution environment that's similar to the one defined by the Lotus/Intel/Microsoft (LIM) 4.0 standard. EXIP refers to applications structured to operate in an Intel 80386 extended-addressing-mode-execution environment.

interface needs a transceiver that's powered by an external power source, such as a wall transformer, which adds about $20 to the cost of the $300 card.

Most network-operating systems, like *LAN Manager* and *NetWare*, use one of two kinds of drivers: Network Device Interface Specifications (NDIS) or Open Data-Link Interface (ODI). These operating systems must be modified for PCMCIA operation, using software drivers supplied with the network card. However, each operating system requires a different set of drivers. Therefore, make sure the network card you're considering buying has drivers for your network software. The most-popularly supported software packages are *NetWare*, *LAN Manager* and *Windows for Workgroups*. (See Table 4 for a representative listing of available network cards.)

A PCMCIA SCSI card gives suitably equipped portable PCs the convenience of using SCSI peripherals like hard-disk and CD-ROM drives, scanners and other peripherals. Like the fax/modem card, the SCSI card has a connector that connects to the desired SCSI peripheral at the end opposite the PCMCIA connector.
Photo courtesy of Amp Inc.)

SCSI Adapter

PCMCIA SCSI adapters provide an effective solution for connecting portable computers to peripherals that are many times their size and weight, including CD-ROM and disk drives, streaming tape, and more. Like PCMCIA network cards, casual SCSI users can share the card with their desktop PCs for cost and bus-slot savings. Average price for a PCMCIA SCSI-2 card with cables is $300.

Until recently, SCSI wasn't a universal interface for DOS and *Windows* users. Too many times, the hard-disk software driver would conflict with the software driver needed

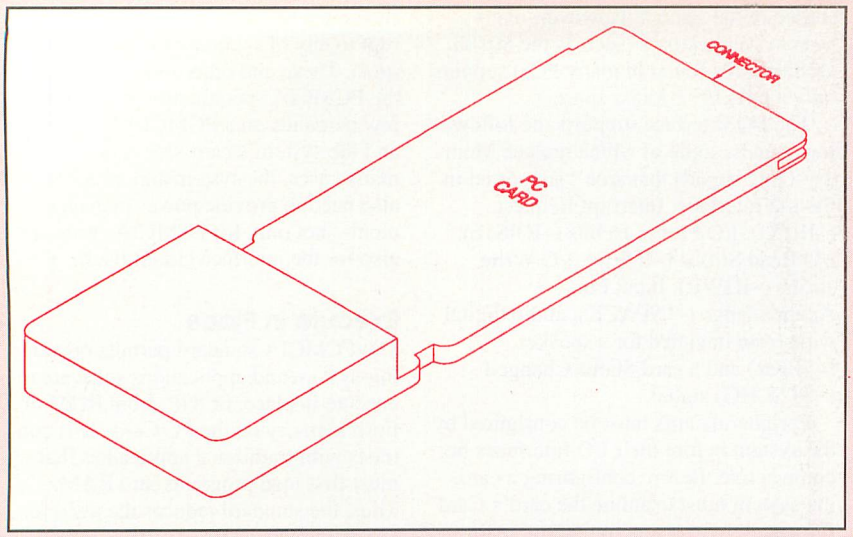


Fig. C. Physical details of the PCMCIA Type I extended 3-D card.

The PCMCIA specification assumes that an XIP partition is used to store XIP applications. In the context of a PC Memory Card, a partition is simply a region of memory within the card's address space.

An XIP device driver is needed to run XIP applications. The XIP device driver is actually split between two device drivers: a high-level driver (XIP.SYS) and a low-level driver (PCMCIA.SYS). The high-level driver simply manages the data in the XIP partition and provides all the services required by the XIP application. The lower-level driver provides the hardware-related services to the high-level driver when it needs to manipulate the mapping hardware (mapping pages, saving or restoring mapping contexts, etc.). By removing hardware dependencies, the high-level driver becomes generic and can be used on any type of system with XIP capabilities.

Features

The features list for PCMCIA cards gives a good idea of the capabilities and hints at the future of this new standard, currently in portable devices but almost certainly to appear in force in desktop units. Here's a layman's run-down of the salient features currently in place for the PCMCIA standard.

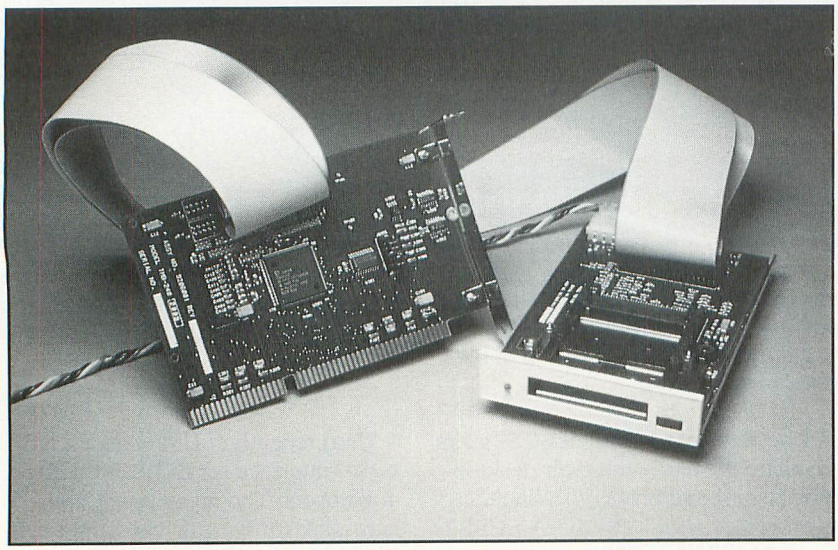
• ***Exchangeable-Card Architecture.*** Exchangeable Card Architecture, or ExCA, is Intel's implementation of Socket Services for the Intel 82365SL host controller. It defines software and hardware interfaces that permit ExCA-compliant PCMCIA cards to inter-operate on many different host systems.

Intel has made ExCA an open specification that can be copied by other manufacturers of host controllers. Since ExCA assumes an Intel-compatible CPU, it isn't relevant to many PCMCIA machines, such as Apple's Newton and AT&T's Hobbit Personal Communicator. Also,

PCMCIA On The Desktop

PCMCIA isn't limited to just the notebook and mobile computers. It's just as much at home on your desk as it is on the road. Basically, there are two ways to add PCMCIA to your desktop. One is via a black box, such as the CardPro from Data I/O. The other is through an internal drive that looks a lot like a 3½" floppy-disk drive, such as the ThinCard Drive from DATABOOK Inc. shown here. The ThinCard Drive can accept Type III PC Cards up to 14.5 mm tall and comes with the award-winning *CardTalk* software. Priced at just $249, it's the ideal way to keep your notebook and desktop communicating with each other.

(Photo courtesy of DATABOOK Inc.)



to run the CD-ROM drive. Fortunately, most PCMCIA SCSI cards ship with *CorelSCSI!*, either as included software or as an option. Licensed from Future Domain, *CorelSCSI!* contains drivers for virtually every SCSI product in existence. And because the drivers are written by one company, there are no conflicts.

A recent Future Domain development is *PowerSCSI!*, a low-level operating system that lets software drivers written for any SCSI peripheral be used together without conflict. *PowerSCSI!* ships with Future Domain's SCSI2GO PCMCIA SCSI adapter card and can be purchased separately for $79 retail.

Plug-and-Play PCMCIA Blues

In theory, you should be able to effortlessly swap PCMCIA cards in and out of your notebook or desktop PC, changing functions and features at will. Unfortunately, it's not all that easy. Compatibility tests that I ran using several notebook PCs and representative PCMCIA cards revealed that

(Continued on page 106)

By Fred Eady

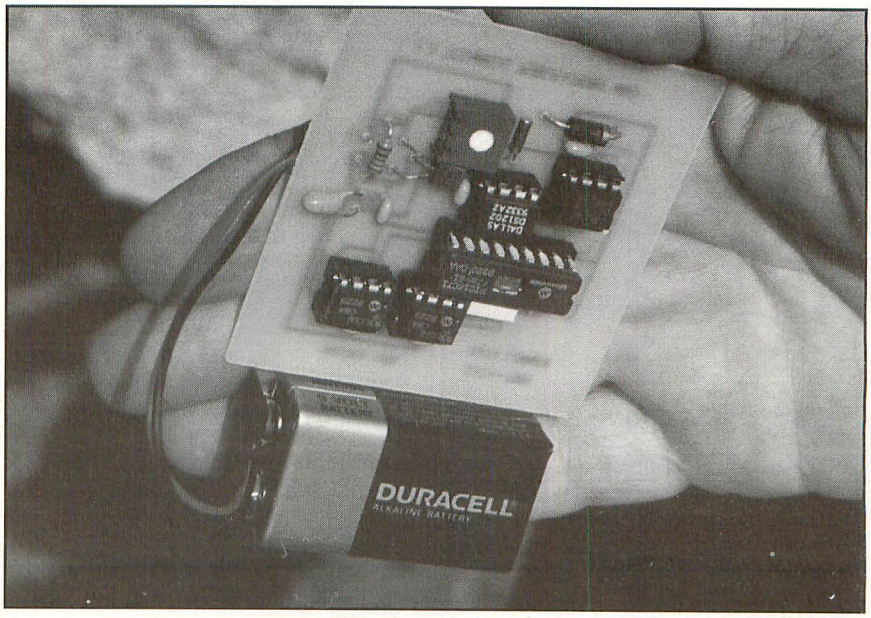
Build a Battery-Powered Data Logger

Use this compact portable device with your PC to automatically monitor any of a wide variety of physical parameters

Information gathering—commonly known as data collection in computing circles—has become an important adjunct to modern personal computing. On their own, of course, machines can't collect and assimilate data in the intelligent manner we do, but they can be directed or programmed to do so in their own way. These devices, also known as data loggers, can be mechanical, electronic or hybrid (electromechanical) in nature. They use many different means to obtain data from their immediate surroundings, but the bottom line is that almost all data loggers use changes in voltage or current presented to their inputs by sensors of various kinds.

The Data Logger (I call it the Data-Twig because it's so small and compact that it's more a "twig" than it is a "log") I'll describe here is a very compact Microchip PIC16C71 microcontroller-based, battery-powered unit that contains enough EEPROM for nonvolatile logging of 1,000 voltage readings (physical events). A Dallas Semiconductor Realtime Clock IC and a companion RS-232 communication IC provide time-keeping and serial communication facilities. Using the PIC16C71's integral eight-bit A/D converter, the Data Logger can sense and store voltage readings from almost any type of sensing device, as long as the sampled input is between 0 and +5.12 volts dc. Measurement intervals can range from once every 10 seconds to once a day.

The Battery-Powered Data Logger I'll present is compact and completely portable. It requires very little in the way of interfacing circuitry to be used with any of a wide variety of sensing devices and a PC, and its software requirements are modest. The cost of building the Data Logger is modest as well—just $80.



About the Circuit

As shown in Fig. 1, the Data Logger's circuit is comprised of only five ICs and 13 support components. A host program that resides and executes on any DOS-based PC that has a serial port provides time data load and dump capabilities via a three-wire 9,600-bps serial connection. (You can download this DATATWIG.EXE program free of charge from the E D Technical Publications BBS at 407-454-3198.) Once you've downloaded the sample interval and time of day to the Data Logger, PIC16C71 *U2* takes over and supervises collection and archiving of data presented to its internal A/D converter.

DS1202 *U1* is initialized with the downloaded time information and its internal oscillator is started. This chip is monitored and time is accumulated until the downloaded time interval is reached. Data is sampled by *U2* on the occurrence of each user-selected time interval. For instance, a typical interval could be once every 15 minutes. Collected data is then stored in a 93LC66 serial EEPROM array consisting of *U3* and *U4*. If you reach the 1,000-sample limit, the Data Logger stops all logging operattions and goes into super-low-power mode until power is removed. No data is lost because the EEPROMs are nonvolatile.

Now that you have an overview of the internal operation of the Data Logger, let's take a look at the functions of each IC in detail. In the following discussions, I'll refer you to figures specific to each device and

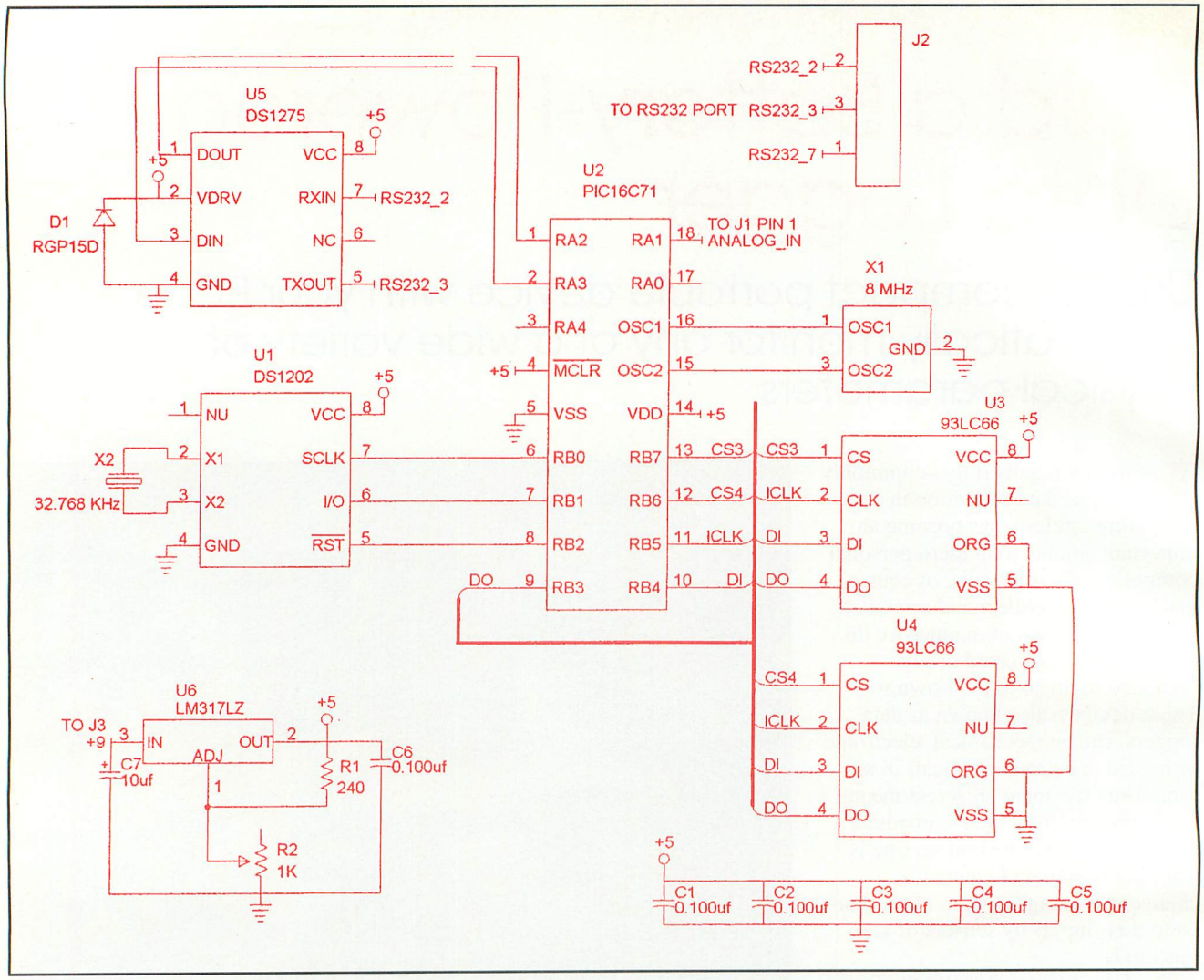


Fig. 1. The Data Logger's relatively simple circuit consists of only five ICs and a double-handful of other components.

provide parenthetical statements that refer you the specific locations in Fig. 1.

• ***DS12-2 Serial Timekeeping Chip*** (Fig. 2). For meaningful interpretation of logged data, the data must be tied directly to a particular time. The Data Logger uses the Dallas Semiconductor DS1202 for this purpose. The DS-1202 contains a crystal-controlled realtime clock that communicates with the PIC16C71 microcontroller via a simple serial interface and provides seconds, minutes, hours and day information to the PIC. Interfacing the DS1202 to the PIC is simplified by using synchronous serial communication. Only three lines are needed to communicate with the IC: RST (reset), I/O (data) and SCLK (serial clock). The DS1202 is designed to operate on very low power and retains clock information on less than 1 microwatt of power.

Time data entered in the host program is transferred serially to the PIC, and microcode inside the PIC initiates data transfer that sets and arms the DS1202. The main elements of the DS1202 are shown in Fig. 2. To pass data to and from the DS1202, RST (pin 8 of *U2*) is taken high and eight bits are loaded into the shift register to provide both address and command information. Data (pin 6 of *U1* from pin 7 of *U2*) is serially input on the rising edge of SCLK. SCLK transitions are effected in the PIC microcode and emanate from pin 6 of *U2*. After the first eight clock cycles have occurred, which load the command word into the shift register, following clock cycles output data for a read or input data for a write operation. Consult the fully commented source code (DATA-TWIG.ASM) for the layout and definition of the commands used by Data-Twig (available from the E D Technical Publications BBS).

Time data, obtained every second from the DS1202 by the PIC, is used to derive the measurement interval loaded into the PIC's internal RAM.

• ***PIC16C71 Microcontroller*** (Fig. 3). As previously stated, Data-Twig is based on the new Microchip PIC16-C71 microcontroller. This low-cost, fully static CMOS, EPROM-based, eight-bit device is unique because it incorporates a built-in eight-bit analog-to-digital (A/D) converter and employs a RISC-like instruction set made up of only 35 single-word instructions, each of which is 14 bits wide. Single-word execution time with a 16-MHz clock is 200 ns, which

PARTS LIST

Semiconductors
D1—RGP15D Schottky diode
U1—DS1202 serial timekeeper
U2—PIC16C71 microcontroller (programmed)
U3,U4—93LC66 serial EEPROM
U5—DS1275 RS-232 converter
U6—LM317LZ adjustable voltage regulator

Capacitors
C1 thru C5,C6—0.1-µF monolithic
C7—10-µF, 10-volt electrolytic

Resistors
R1—240 ohms, 1/4-watt, 5% tolerance
R2—1,000-ohm pc-mount trimmer potentiometer

Miscellaneous
X1—8-MHz ceramic oscillator
X2—32.768-kHz crystal
Printed-circuit board or perforated board with holes on 0.1" centers and suitable Wire Wrap or/and soldering hardware (see text); 9-volt dc power supply (see text); ribbon cable; sockets for DIP ICs; hookup wire; solder; etc.

Note: The following items are available from E D Technical Publications, PO Box 541222, Merritt Is., FL 32954 (tel.: 407-454-9905 for ordering, technical assistance and fax or 407-454-3198 for BBS): Data-Twig starter kit (contains ready-to-wire pc board and programmed PIC16C71), $39.95 and full kit (contains pc board, programmed PIC-16C71, all Dallas Semiconductor chips, all Microchip chips crystals, LM317LZ, resistors and capacitors), $79.95. Add $% P&H per order. Also available is a 3½" DOS-format software diskette for $10 postpaid. Florida residents, please add state sales tax. Microchip ICs are available from Digi-Key Corp. by calling 1-800-DIGIKEY and Dallas ICs are available from Dallas Semiconductor by calling 1-800-336-6933.

equates to a 2:1 code compression and a 4:1 speed advantage over other microcontrollers in this class! The Data-Twig Data Logger uses an 8-MHz clock for a 500-ns cycle time.

High microcode execution speed is achieved in the PIC16C71 using Harvard architecture, or the Harvard dual-bus concept, instead of the classic Von Neumann, or single-bus, implementation. Harvard architecture is register-file-based, with a separate bus and memory space allocated for instructions and data. This simply means that all program-controlled objects—such as I/O ports, memory locations and timers—are physically implemented as hardware registers.

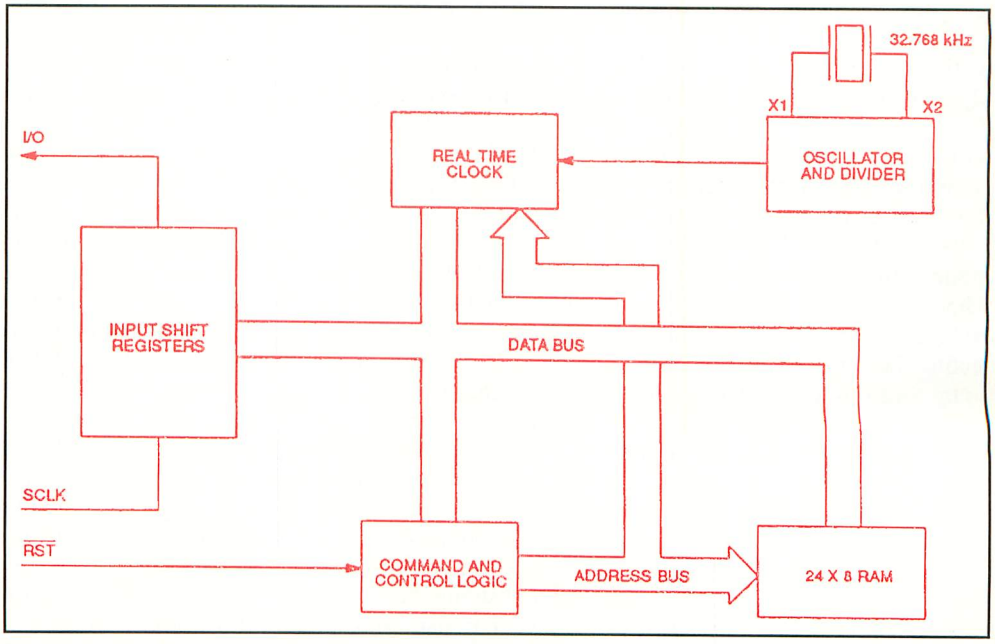
The PIC16C71 data memory (RAM) bus is eight bits wide, while the program memory (EPROM) bus is 14 bits wide. Using the Harvard dual-bus configuration permits the PIC to perform high-speed bit, byte and register operations. Harvard architecture also inherently permits overlapping instruction execution, known as pipelining, which is the simultaneous execution of the current instruction as the next instruction is being read from program memory. Traditional Von Neumann architecture must fetch instruction and data information over a single shared (multiplexed) bus, which obviates the ability to overlap instruction fetch and execution.

As you can see, the internal logical and physical components that make up the PIC16C71 are similar to any other microcontroller you may have previously encountered. However, the way these common components are interconnected via the dual-bus Harvard architecture is the key to reduced compiled code count and high execution speed of the PIC16C71 microcontroller.

As it relates to the Data Logger, the PIC16C71 oversees communication with the host PC via the serial port, keeps track of the time through a serial channel to the DS1202 Real Time Clock, performs A/D conversion of sensor voltage input and stores user-selected configuration data and information obtained from the sensor via the A/D digital converter in the 93LC-66 EEPROM array.

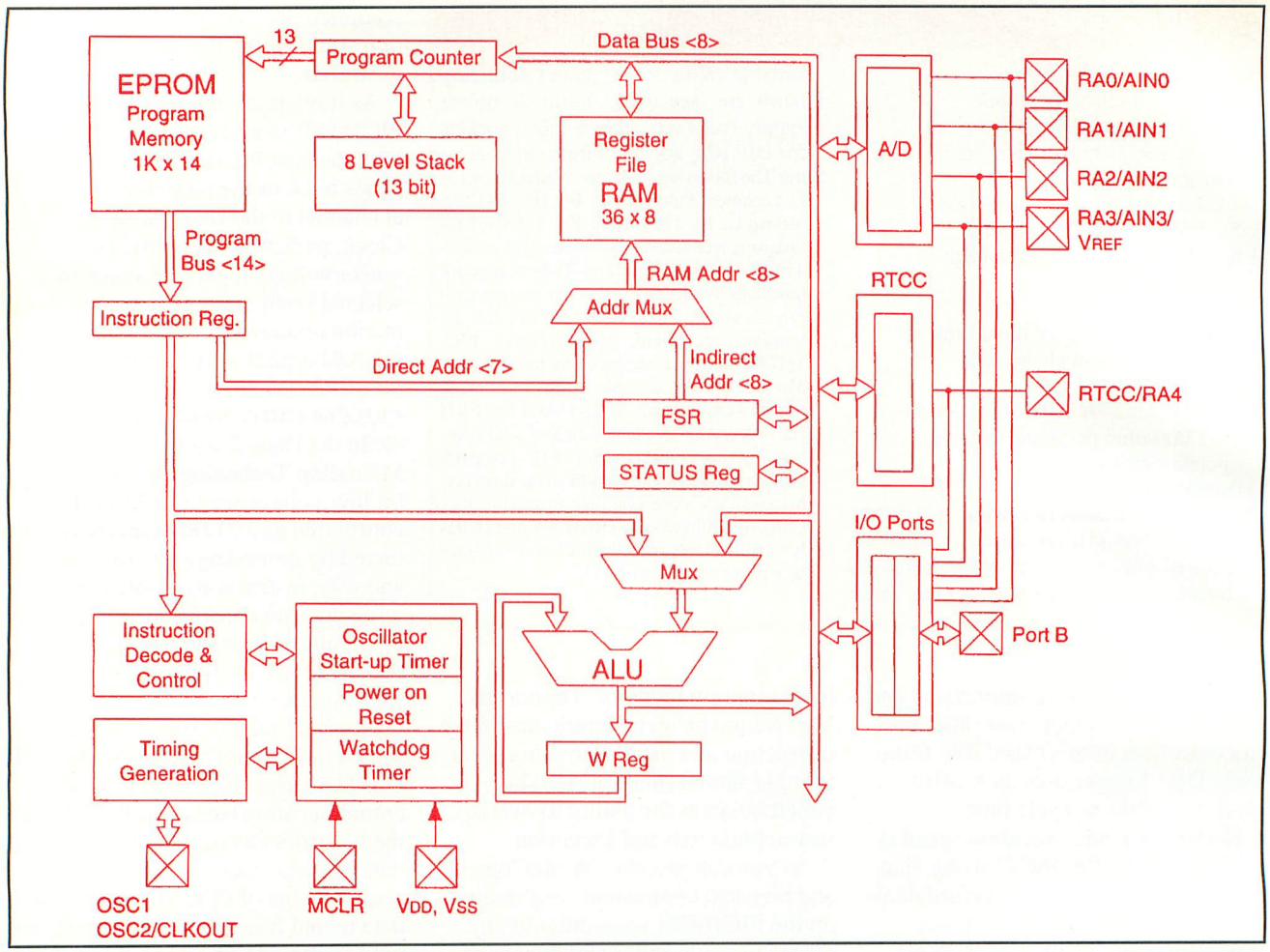
• ***93LC66 CMOS Serial EEPROM*** (Fig. 4). In the Data-Twig Data Logger, the Microchip Technology 93LC66 4K-bit low-voltage serial EEPROM is configured as a 512K-byte device, effected by grounding ORG (pin 6 of *U3* and *U4*). Instructions, addresses and write data are clocked into DI (pin 3 of *U3* and *U4*) on the rising edge of the clock at CLK (pin 2 of *U3* and *U4*). Again, CLK is created in firmware inside the PIC16C71 and presented to *U3* and *U4* from pin 11 of *U2*. The serial clock synchronizes communication between the PIC and the 93LC66. Opcode, address and data bits are clocked in and out on the positive edge of CLK. DI and DO pass data to and from the PIC. DO is also used to provide an erase or write-complete indication to the PIC16C71.

No fancy timing cycles are required in the 93LC66 for reading and writing because this chip incorporates built-in



Courtesy Dallas Semiconductor

Fig. 2. Main elements of the DS12-2 Serial Timekeeping IC.



Courtesy Microchip Technology

Fig. 3. Block diagram of the dual-bus PIC16C71 microcontroller.

timers for performing erase and write operations. The device is nonvolatile and provides instructions to disable or enable write operations. Data is automatically protected when power-supply delivery falls to less than 1.4 volts dc. You can expect a million erase/write cycles before data integrity is compromised, and static data retention is rated in excess of 40 years.

Each 93LC66 is kept in standby mode until selected. Selection occurs when CS (pin 1 of *U3* and *U4*) is taken high. The PIC is responsible for selecting the correct EEPROM and does so by controlling the CS lines via its pins 12 and 13. Standby mode consumes about 5 A of current, while active mode needs about 1 mA.

• ***DS1275 Line-Powered RS-232 Transceiver*** (Fig. 5). The 9,600-bps asynchronous interface is implemented with Dallas Semiconductor DS1275 line-powered RS-232 transceiver *U5*. This CMOS device translates RS-232 signal levels to CMOS/TTL levels. To eliminate the requirement for a negative supply voltage, the DS1275 "steals" power from the receive RS-232 signal when it's in a negative-voltage (marking) state. After being translated by *U5*, a mark transposes to a logic 1 (TTL high), a space to logic 0 (TTL low).

The Data Logger operates in half-duplex mode, with its RS-232 data traveling in only one direction at a time. If the host is in receive mode, the Data Logger is in transmit mode and vice-versa. The host PC should mark (negative voltage) or idle (0 voltage) its transmit line when receiving data from Data-Twig (most PC serial ports do). The PC's transmit line is cross-connected to the Data Logger's receive line. This marking state on the PC's transmit line permits the DS1275 to steal negative current and swing the TXOUT pin negative when transmitting a mark. If the host PC spaces (positive voltage) the transmit line during receive, the DS1275's TXOUT line is able to swing to ground only during the transmission of a mark. Typically, to most RS-232 receivers any potential less than 2 volts dc is considered to be a mark. Therefore, the DS1275 is capable of working with its RXIN pin in either the marking or spacing condition.

TTL-level data to be transmitted to the host program is supplied to DIN pin 3 of *U5* from pin 2 of microcontroller *U2* under software control. TTL-level data received from the host program is routed to pin 1 of *U2* from DOUT pin 1 of *U5*. Since the PIC16-C71 doesn't have an internal UART, one was emulated in microcode.

RS-232 I/O is supplied by pins 5 and 7 of *U5*, with TXOUT pin 5 being RS-232 transmit data (to the PC) and RXIN pin 7 acting as RS-232 receive data (from the PC). In a standard RS-232 25-pin DTE configuration, pin 2 of the 25-pin serial connector is transmit data and pin 3 is receive data. Note that pins 5 and 7 of *U5* are wired so

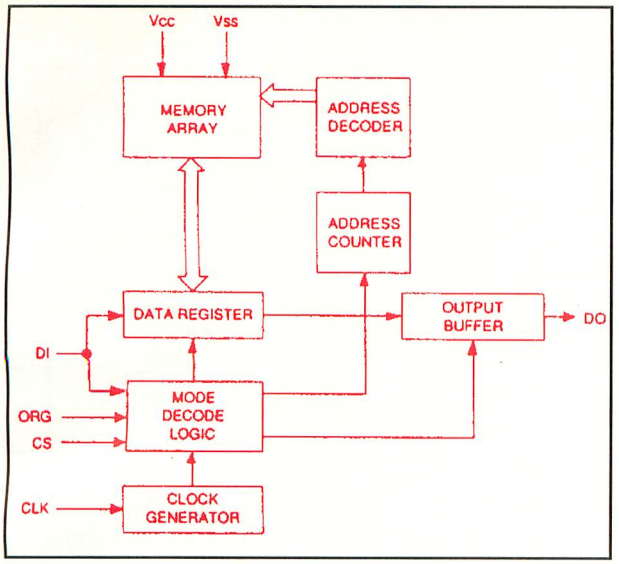


Fig. 4. Block diagram of the 93LC66 Serial EEPROM.

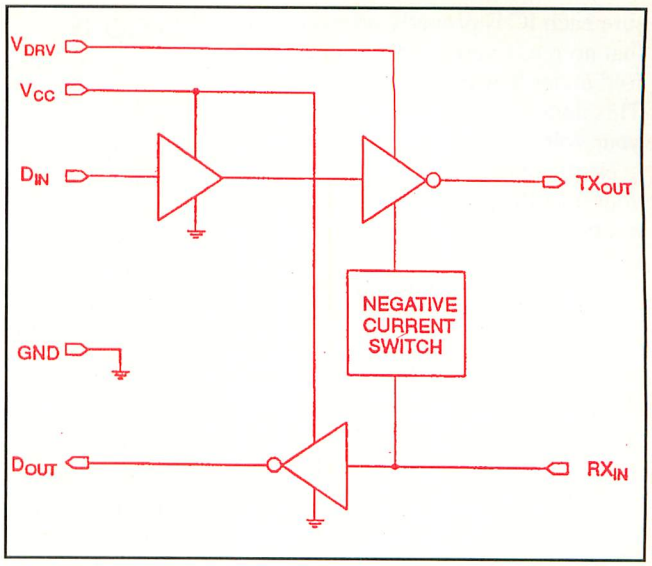


Fig. 5. Block diagram of the DS-1275 line-powered RS-232 transceiver.

that DTE transmit pin 2 connects with *U5*'s receive pin 7 and DTE receive pin 3 connects to *U5*'s transmit pin 5. Pin 7 of the 25-pin serial connector provides for a common ground. This arrangement constitutes a miniature null-modem in that other modem signals (DTR to DSR, RTS to CTS and CD to DTR) aren't cross-connected. The DATATWIG host program obviates the need for the PC serial port to reference or act on any other modem signals, except transmit and receive data.

Schottky diode *D1* is used to prevent DS1275 latch-up. The DS1275 gets very hot and ultimately destroys itself when latch-up occurs. If power (+5 volts) is removed from U5 and the RS-232 transmit line is in a marking (negative) state, a diode inside the DS1275 turns on and causes a latch-up condition. Inclusion of Schottky diode *D1* that has a lower clamp voltage than that of the internal diode prevents the internal diode from turning on thus circumventing a destructive latch-up condition.

Referring back to Fig. 1, *U1* through *U5* are bypassed at the power level by *C1* through *C5*, respectively.

Accurate timekeeping is assured with the 32.768-kHz crystal connected to *U1* at pins 2 and 3. Ceramic 8-MHz oscillator *X1* ensures that clock pulses provided to the DS1202 and the 93LC66 ICs are within the timing specifications required for proper operation of each device. This oscillator also provides the means for extracting the 104-s bit window needed for 9,600-bps serial communication via *U5*.

The Data Logger requires a 9-volt dc at 20-mA power source. Capacitors *C7* and *C6* provide input filtering and noise/oscillation cancellation on the output of voltage regulator *U6*, respectively. LM317LZ adjustable voltage regulator *U6* is in standard configuration, providing +5.12 volts to Data-Twig's power rail. Trimmer potentiometer *R2* provides a means for adjusting the output of *U6* to exactly +5.12 volts. This is necessary because the PIC16C71's internal A/D converter references the V_{DD} power rail. At +5.12 volts, each bit of the digital data sampled is equal to 20 mV. Although V_{DD} can be varied, the PIC16-C71's A/D converter is most accurate with a +5.12-volt reference.

If you require more in-depth information for an application in which you'll be using the Data-Twig Data Logger, I suggest you obtain the following references:

Dallas Semiconductor 1993 Product Data Book
Dallas Semiconductor
4350 S. Beltwood Pkwy.
Dallas, TX 75244-3292
Tel.: 214-450-0400

Microchip Data Book
Microchip Technology, Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224-6199
Tel.: 602-786-7200

Construction

Begin construction by fabricating a single-sided printed-circuit board, using the actual-size artwork given in Fig. 6. If you prefer, you can assemble the circuit on perforated board that has holes on 0.1" centers using suitable Wire Wrap or/and soldering hardware. If you wish pc construction but prefer not to fabricate your own board, you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List.

Once you have a working board, refer to Fig. 7 and mount and solder into place all sockets for the DIP ICs. Then mount and solder the remaining components into place. Don't solder any leads or pins into place for *C7*, *D1*, *U6* and *X1* until you're certain of proper orientation and basing for these components. Do *not* plug any of the DIP ICs into their sockets at this time.

Clip the "hot" probe of a dc voltmeter or a multimeter set to the dc-volts function to the cathode lead of *D1* and the common lead to the anode lead. Apply a suitable 9-volt dc power source to *J3*. Observe proper polarity when making these connections. Then adjust *R2* for a +5.12-volt reading across *D1*. Check the voltages on each +V pin of each DIP IC socket, referring back to Fig. 1 to guide you. Once you're satisfied that all power points check out, disconnect power from the circuit and plug the DIP ICs into their respective sockets. Make

sure each IC is properly oriented and that no pins overhang the sockets or fold under between ICs and sockets. This done, power up gain and recheck your voltages.

Next, connect the Data Logger to your host PC's serial port. Load and run the DATATWIG program. If everything continues to check out okay, the program will display a banner and ask if you want to upload or download. At this time, the Data Logger is ready for use. If the Data Logger isn't able to communicate with the host program for any reason, an error message will appear. Should the error message be displayed, disconnect power from the Data Logger and recheck your work. Look for solder bridges, cold solder joints, missed connections, etc. Correct whatever is wrong and try again.

Using It

When the Data Logger is powered up, it enters command state, at which point you can either upload stored EEPROM data or download interval data at this time. In download mode, the DATATWIG program prompts for day, hour, minute and second interval information and then asks for current time of day. Error checking is accomplished within the confines of the host program, and the data is automatically transferred to the Data Logger when everything is correctly entered. At this point, the Data Logger enters data-collection mode and ignores any serial inputs until power is removed and restored.

Upload mode requests a filename for the data you're about to extract from the Data Logger. When you enter a valid filename, data transfer from the Data Logger commences. Uploaded data is stored as raw voltage in ASCII format. Unlike download mode, you'll remain in command state following an upload request.

Here's an example of a typical data record example:

12:00	(Start time you entered)
00:00:15:00	(15 minute interval you selected)
1.25	(voltage data at 12:15)
2.34	(voltage data at 12:30)
...	...
3.45	(voltage data at 12:45)

As you can see, you can use the data in any way you like for analysis purposes.

You can connect any type of sensor configuration you desire to the Data Logger, as long as its output is between 0 and +5.12 volts. Try not to load the analog input with excessive capacitance because the PIC's A/D converter uses an internal sample-and-hold arrangement. The data sheets also direct you to keep input impedance to less than 10,000 ohms for the same reasons. Exceeding these limits will reduce the accuracy of A/D conversion.

Every 60 seconds, the Data Logger will transmit the asterisk (*) character to its serial port. This is a "heartbeat" that allows you to connect a laptop or data monitor to the Data Logger at any time to make sure that it's, indeed, operating because there are no visual means of doing so.

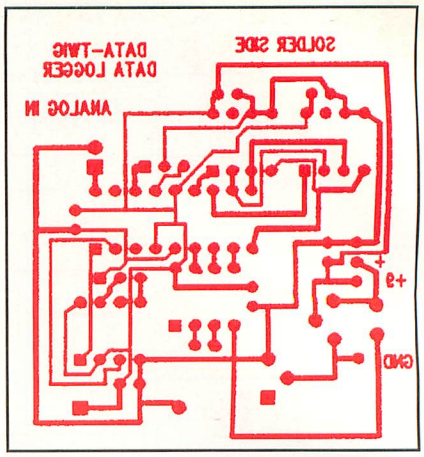


Fig. 6. Actual-size etching-and-drilling guide for fabricating the printed-circuit board needed for the Data Logger.

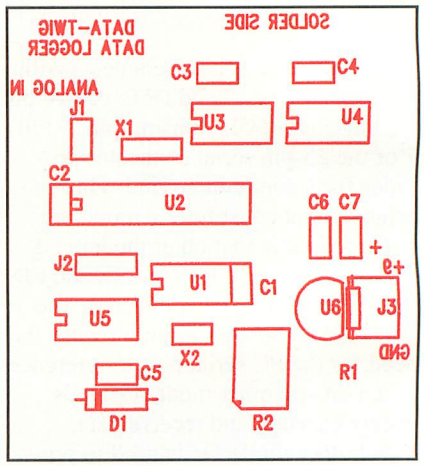


Fig. 7. Wiring guide for the Data Logger's pc board.

You can exit data-collection mode at any time simply by removing power from the Data Logger. Upon powering up again, the Data Logger enters command state and opens its serial port to the host system.

If you don't already have a sensor that you can test with the Data Logger, build the power circuit consisting of *R1*, *R2*, *C6*, *C7* and *U6*. Connect the output to analog input pin 18 of *U2*, start the Data Logger and monitor the output voltage with a digital voltmeter. Vary the voltage for every measurement interval. This will give you an idea of how the Data Logger works and provides an understanding of what occurs when your particular sensor is connected and operational. ■

By Hardin Brothers

Pointing Devices

An inside look at the ubiquitous mouse, types available, maintenance and buying tips and a brief look at other pointing devices

Though it's one of the of the first skills we learn as small children to tell those around us what we want, pointing arrived comparatively late to personal computing. Some early personal computers had joysticks for playing games, but almost none had pointing devices. The few available light pens of the day were more for hobbyist experimentation that for serious computing.

The first computer mouse was invented in 1963 at Stanford Research Institute by Doug Engelbart. Few computer users noticed its arrival. This first crude mouse consisted of a wooden cube with a small momentary-contact switch on its top. Inside the cube and protruding from the bottom were two metal wheels that rotated as a user moved the mouse. The wheels were connected to the shafts of two variable resistors. The software sensed the resulting voltage variations to move an on-screen cursor.

The first mouse wasn't a huge success. Apparently, only a few prototypes were ever made. Contributing to its demise was the fact the analog signals it produced were difficult to handle with software.

In the early 1970s, Xerox's Palo Alto Research Center (PARC) commissioned the first commercial digital mouse for its Alto computer. Although the Alto was a commercial flop (less than 100 were sold), it was one of the most-important computers ever developed. In fact, many of the ideas behind the Apple Lisa and Macintosh computers—as well as Microsoft's *Windows*, IBM's OS/2 and the Unix *XWindow* environments—can be traced back to PARC and the Alto computer. The Alto's use of a mouse set a standard that still influences almost all modern software and computer-system design.

Mouse Anatomy

Most modern mice for IBM/compatible computers consist of an umbilical cord with a connector at the end opposite the mouse for hookup to a computer, a plastic body, two or three buttons on the top of the mouse's housing for activation purposes and a hard rubber ball recessed into the bottom of the housing. As a user moves a mouse, the rubber ball rotates. It rolls against two or three positioning rollers and two motion sensors. One sensor monitors vertical movements, the other horizontal movements.

Internal motion sensors are connected to circuitry located inside the mouse's body. In most mice, the connection is mechanical or optical. Mice of the first type are called "mechanical" and those of the second type are termed "opto-mechanical." Because an optical linkage tends to be more sensitive to small movements and has less internal friction, most modern mice are of opto-mechanical design.

If you want the ultimate in control and accuracy, look for a fully optical mouse. These rodents are used mostly for high-end CAD and scientific work. Instead of a ball moving against your desk or a mouse pad, an optical mouse must be used with a special sheet of glass or metal with an etched grid on it. Optical sensors in the mouse record the mouse's movement relative to the grid. Because the grid is fixed, there's no chance for the minor slippage and inaccurate movements that sometimes occur with the mechanical or opto-mechanical mouse. Be adviced, though, that, if you use an optical mouse you must keep the grid pad clean.

A standard mouse attaches to a computer via a thin umbilical cable. Most people prefer longer cables because these permit more flexibility in positioning the mouse and setting up a computer desk, especially if the computer is placed on the floor or hidden in a cabinet.

The mouse cable—or "tail," as it's sometimes called—can be attached to the computer in one of three ways. Many models of the IBM PS/2 computer and some laptop and notebook computers have a port that's designed especially for attaching a mouse. On most machines, you'll have to choose between a serial and a bus mouse.

A serial mouse attaches to your computer through a serial or COM port. If you have a spare serial port, attaching such a mouse is simply a matter of plugging it into the connector on the back of your computer that goes to the serial port you've chosen. Most serial mice are supplied with both nine- and 25-pin serial connectors to permit you to plug them into any standard serial port.

Disadvantages of a serial mouse become apparent only if you have two or more serial devices in addition to the mouse—perhaps a modem and a serial printer. Although the BIOSes of most ISA (Industry Standard Architecture) computers, along with DOS, have support for up to four serial ports, you generally can use only two ports at the same time. Normally, COM1 and COM3 can't be used simultaneously, nor can COM2 and COM4. Juggling serial ports may be interesting at first, but it becomes irritating over time. The best way I've found to avoid port conflicts on a computer

with a serial mouse is to connect the mouse to one serial port and use a switch box to connect all other serial devices to a second serial port.

A bus mouse attaches to a special adapter card installed inside your computer. The advantage of a bus mouse is that it leaves your serial ports free for other accessories. The disadvantages are that you have to give up one of your computer's expansion slots for the adapter card and you sometimes have to fiddle with DIP switches on the card until you've resolved any conflicts between the mouse card and other expansion cards in your system. Also, a bus mouse often costs more than a serial mouse because of the interface card that comes in the package.

The Software Connection

Mechanically, most mice are about the same. Electronically, they can be quite different, although there's a tendency towards emulating the electrical behavior of Microsoft's mice. The burning question is: Will a mouse, whatever its mechanical and electronic characteristics, work with your software? The answer is: Most likely.

With very few exceptions, programs don't interact directly with a mouse. Instead, they use an API (Application Program Interface) that's consistent from one mouse type to another. It makes no difference to the program whether you have Microsoft, Logitech or Brand X mouse. Programs rarely know and almost never care whether the mouse is attached to a mouse port, a serial port or a bus card. All they care about is whether the mouse and its software follow the normal mouse API.

The API is created by a program named MOUSE.SYS, MOUSE.COM or something similar. The program is created to control a particular mouse from a particular manufacturer, but to an application program, all mice look the same. If you use a .SYS mouse program, you load it from your CONFIG.SYS file. If you use a .COM mouse program, you load it from your AUTOEXEC.BAT file or from the command line. Otherwise, both programs are much the same.

DOS-based applications expect a mouse to be available through a software interrupt, in much the same way that applications interact with DOS and the computer's BIOS. The API has grown over the years, but it remains compatible with its earlier versions, which means that older mouse-compatible software should have no problem working with a modern mouse.

The API lets software perform the activities you'd expect, including: initializing the mouse, displaying and changing the mouse cursor, reading the current state of the mouse buttons and mouse position at the last button click, etc. Programs can also use the API to determine whether the mouse has two or three buttons, to save or restore the mouse state, to limit the mouse's movements on the screen and to perform many other activities.

One of the problems of an evolving API is that many sophisticated programs make use of as much of the standard as possible. If your mouse driver is outdated, it won't provide all of the services that a more-modern application expects. Therefore, if you install a new DOS application that doesn't seem to use your mouse correctly, you should contact the manufacturer of your mouse to see if a new driver is available. If you use a Microsoft mouse or a mouse that's electronically compatible with the Microsoft drivers, you'll automatically get the upgraded driver every time you install a new version of MS-DOS or most Microsoft DOS-based applications that use the mouse and mouse driver.

The standard mouse driver is for DOS applications, not for Microsoft *Windows*. If you have a Microsoft- or Logitech-compatible mouse, *Windows* 3.1 contains a driver that will work with it. If not, you'll need a *Windows* driver for your particular mouse. Once *Windows* is communicating correctly with your mouse, you won't have to worry about drivers for any *Windows* application. One of the best features of *Windows* programs is that they use *Windows* itself for hardware services instead of trying to manipulate the hardware directly. Once a mouse, printer, modem, scanner or any other piece of hardware is working correctly with *Windows*, it should continue to work with all *Windows* applications. However, you may have trouble with DOS applications that use a mouse after you install *Windows*.

The problem with the DOS situation is that you can't expect *Windows* to provide mouse services for applications that run in a DOS session under *Windows*. Fortunately, the solution is simple. Just make sure your mouse driver is loaded before *Windows* starts. Then all DOS programs—those you run before *Windows*, those that run from *Windows* and those that run after you exit *Windows*—will be able to make use of your mouse.

Mice were once shipped with a disk filled with utility programs, from mouse-driven DOS shells to authoring systems that would let you create a mouse interface for almost any application program. Nowadays, the mouse software wars seem to have diminished, partly because the programs were ignored by most users and partly because the mice are apt to be used with the DOS shell, *Windows* or modern applications that already include mouse support.

Mouse Care and Feeding

All mice require occasional maintenance. Luckily, servicing a mouse is easier than almost any other computer-maintenance task.

Eventually, your mouse will gather dust or dirt on the rolling ball and deposit it on the rollers inside the mouse. If you have an opto-mechanical or optical mouse, dirt and dust can clog the sensors and cause your mouse to malfunction. A mouse rarely stops working completely. Instead, the dirt and dust make the cursor skip, drag or jerk as you move it around the screen.

In all cases, the cure is easy. Just remove the dirt and dust. For mechanical and opto-mechanical mice, you can buy a cleaning kit from some computer supply stores. Some kits aren't much more than a pre-moistened towelette. They instruct you to roll the mouse on the towelette and, by so doing, presumably carry the cleaner from the ball into the interior of the mouse.

You can do a much better job, at a lot lower cost, if you have a few cotton swabs and some 90% or stronger alcohol from a drug store. First turn off your computer and unplug the mouse. If you work with the mouse installed and the computer powered up and running an application program, you'll likely generate random mouse movements and clicks while

you're cleaning the mouse. You'd be amazed at how much damage such random mouse signals can do in *Windows*, a DOS shell and many application programs.

The mouse ball is held in position at the bottom of the mouse's case with a small plastic "cage." You can remove the cage by sliding or rotating it. With the cage removed, you can easily take out the ball. In fact, it's likely the ball will fall out all by itself, roll onto the floor and your dog will thank you for his new toy as he runs off with it clamped between his teeth.

Once you've recovered the ball, clean it thoroughly and examine the inside of the mouse. You'll probably see three rollers and two motion detectors. The motion detectors will probably look like a second kind of roller. Your task is to remove all dirt and dust from the ball, the rollers, the motion sensors and the rest of the interior of the mouse.

Begin cleaning with dry cotton swabs. If the dirt is relatively fresh, this may be all you need to do. If dry swabs fail to remove all of the dirt, moisten them with alcohol. If the swabs are damp—not soaking wet—they'll do the best job of cleaning the inside of your mouse.

Once you've removed all dirt, let any remaining alcohol evaporate. Then place the ball back in its recess in the mouse's case, close the cage, connect the mouse to your computer and power up your system. If you clean your mouse every month or two, it should give you several years of reliable service.

An optical mouse doesn't have a rolling ball, but the same general cleaning rules apply. Also make sure to keep the mouse grid clean. Any dirt on it will make the mouse skip just as surely as dirty sensors inside the mouse will.

Mouse Models

Most of us have a preconceived idea of what a mouse looks like and how it should work. However, mouse manufacturers apparently lack these preconceptions. Some mice are so unusual in appearance that it's difficult to recognize them at all.

Standard mice started as clunky-looking objects but have since evolved into streamlined ergonomic

masterpieces. The best ones work equally well for right-and left-handed users. If you're left-handed, don't limit yourself to symmetrical mice that will feel the same in either hand. Many modern mice will fit differently in each hand but work equally well, whether you place them on the left or right of your keyboard.

If you're buying a traditional mouse, try using several different models until you find one that's right for your hand. Just moving a mouse around on a store shelf won't tell you much. You'll be better off if you convince the salesman to connect each mouse to a demonstration computer and let you work with it for 10 or 15 minutes. There's little difference between traditional mice, except for their shape and how they feel in your hand. You don't have to feel bound to any particular brand name.

A traditional mouse with a 6- to 10-foot umbilical cable may seem too tame for your tastes. Perhaps a wireless mouse would be more to your liking. A wireless mouse is great if your desk is too small or too messy for a cord, or if you need to move the mouse a long distance from your computer. For example, you could use a wireless mouse from the far side of a large conference table while you give a presentation on your computer. A wireless mouse contains a transmitter that sends signals to a receiver that attaches to your computer like a traditional mouse.

Some wireless mice work with infrared transmitters and receivers, much as your TV and VCR remote controls do. I recommend that you avoid these mice in the workplace because the IR signals tend to bounce around an office. Your TV is probably in a room with draperies, upholstered furniture, a carpet and other matte surfaces that absorb stray signals. In an office, however, shiny furniture, printer stands and other computer accessories, filing cabinets, window glass and blinds and a host of other reflective surfaces can send IR signals bouncing everywhere. The result, at least with one IR mouse I tested some time ago, was that the receiver constantly picked up reflected sig- nals and thought the mouse was moving and clicking randomly throughout the room.

Radio-controlled wireless mice, like the new Logitech MouseMan Cordless, are much more stable and useful. Since they usually have a way to set the frequency or signal pattern they use, like garage door openers, you can use more than one such mouse in an office. Except for the missing "tail," you probably won't realize that you're using a wireless mouse instead of a traditional one.

Some users don't want to give up the room on their desks required for a mouse to move. Many of them choose a trackball, which is essentially a mouse turned upside-down and you move the ball rather than the entire mouse mechanism. When you use a trackball, you move a ball with the palm of your hand or the tips of your fingers instead of moving an entire mouse assembly around your desk. Its greatest advantage, especially if you're a touch typist, is that the trackball doesn't move. You can shift your hand to the trackball and back to the keyboard without ever looking at your hands.

Either you like the feel of a trackball or you don't. I prefer moving a mouse to make the cursor move, but my wife has preferred a trackball for years. If you decide to try a trackball, dozens of models are available. Select one that makes it easy to hold down a button and move the ball simultaneously, especially if you want to drag objects around in *Windows*.

Users of laptop and notebook computers often don't have room for a mouse or a trackball, especially on airplane fold-down tables and when they're balancing their computers on their laps, trying to jot down a few notes. For them, two solutions have become most popular. One is a very small trackball that clips onto the side of their computers. The other solution is a small, built-in joystick that you can move without moving your fingers from the keyboard. I prefer the joystick approach, if only because I'm apt to lose or damage anything that's attached to the outside of my notebook computer.

Other Pointing Devices

Several unusual pointing devices have found only small niche markets. Pen-point mice, for example, seem like a great idea and are for those people who want to trace drawings into a graphics program. But for everyday use, a pen-point mouse, which looks something like a large pen with a cord attached to it, probably isn't practical. You have to stop typing and then pick up the pen and adjust it in your hand whenever you need to work with the mouse. Also, I've heard some users complain that the small ball in the pen point tends to skip or skid more often, and pick up dirt faster, than a traditional mouse does.

There are also a number of specialized pointing devices for CAD, desktop publishing and other specialized uses. The most popular is probably a digitizer, which is a special large pad and an attached pointing device. Since, the pad works by location, not relative movement, you can position the mouse cursor quickly just by moving the pointer to the appropriate location on the pad. Also, you can use the pointer to trace architectural drawings and, in some installations, select commands from a menu printed on the pad instead of from drop-down lists on the screen. Some digitizer pointers look like pens (but they don't have the rolling ball that's in a pen-point mouse). Others work with a tool that looks like a small magnifying glass with cross-hairs. The design and size of a digitizer is determined mostly by its intended use. Many digitizers include special drivers for the application programs that their manufacturers assume you'll use.

Finally, the ultimate pointing device may be your own finger. Touch-sensitive video monitors or screen overlays let you point to a position on the screen instead of moving a mouse and clicking a button. Usually, a mouse is more accurate than a touch-sensitive screen but is less suitable for demonstrations and public-area information systems. Touch screens are fun to use—until you begin to realize that they just can't locate your finger accurately enough for detailed work.

Summing Up

Whatever pointing device you choose to use with your computer, it owes its inception to those first mice developed at Stanford and PARC. Now that computer mice are more than 30 years old, they're almost as ubiquitous and necessary as more-traditional input and output devices like keyboards and video display screens. ■

By John Kleinbauer

Measuring Temperature the QADDI Way

Using the "Quick and Dirty Data Interface" presented in an earlier issue, you can inexpensively measure temperature with your PC in °F or °C

In the August 1993 issue of *ComputerCraft*, I presented a "Quick and Dirty Data Interface" I call QADDI that uses a serial port to read into a computer analog and digital signals without the need for complicated or costly circuitry. In that article, I showed you how to measure voltage using an A/D chip and a serial card. This time out, I'll show you how to measure temperature in Fahrenheit the QADDI way. The circuit presented here can also be used to measure temperature in centigrade by redoing the software and calibration procedure. I'll be referring to Fahrenheit since most readers will use this circuit for measuring inside or/and outside temperatures.

Measuring temperature has always been a very popular project over the years but there always seems to be at least one component prospective builders of projects had difficulty locating. Using a serial card, A/D chip, operational amplifier and a transistor as the sensor makes measuring temperature with a PC very simple. So if you want to computerize your home with some environmental control devices QADDI is an inexpensive way to monitor temperature for your software. If you're just an experimenter, this is an excellent computer interface project that will also give you some experience with operational amplifiers and simple programming.

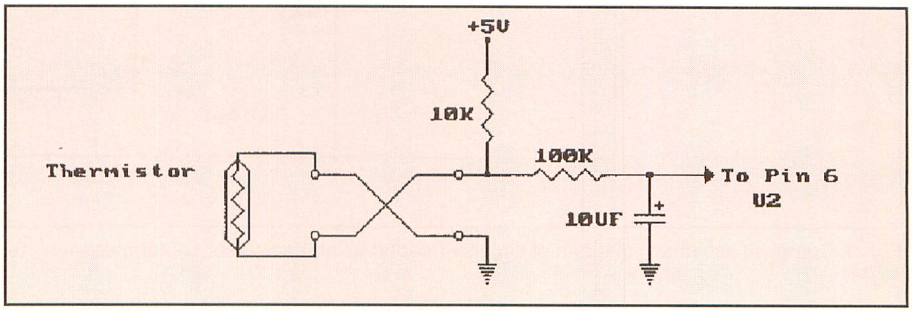


Fig. 1. Typical thermistor-sensor circuit arrangement.

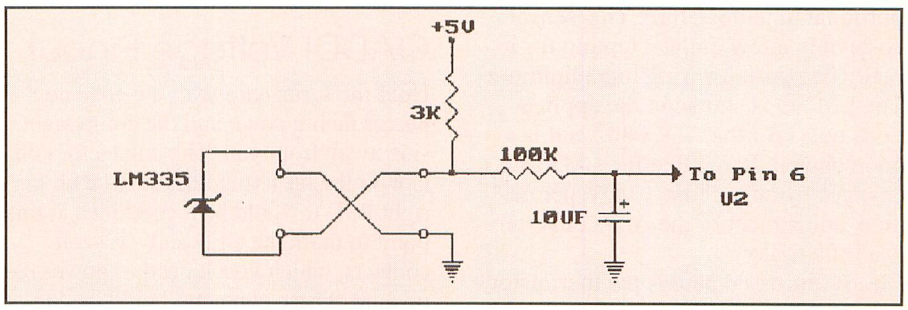


Fig. 2. Typical solid-state LM335 IC-sensor circuit arrangement.

Sensors

I'll be discussing several types of sensors for measuring temperature to tell you exactly why I recommend using a transistor as the sensing element. Three of the most commonly used sensors include the thermistor (Fig. 1), the IC sensor and the semiconductor junction. There are also the thermocouple, which gives off voltage (I won't be discussing this type here, though), and a 100 ohms worth of No. 36 copper wire, which changes resistance with temperature. I did some experimenting with the copper wire but found it changed by only about 10 ohms from 33° to 85°. This very small change, though very linear, required too much amplification, and the sensor turned out to be physically quite large. The copper-wire sensor has been used by the scientific community over the years with a Wheatstone bridge circuit. Feel free to travel this road using a second op amp to obtain the voltage swing needed for the circuit.

Of all the sensors available, the most practical is a diode or transistor junction. Since every experimenter has at least one diode or transistor kicking around in his spare-parts box, this is the best choice. The only drawback is that you need to amplify the output voltage with an op amp to make it usable. Unlike other projects that require a center-tapped transformer to obtain a split supply for the op amp, QADDI has +12- and –12 volts on the serial card waiting to be tapped.

The next choice for a sensor is the LM335 precision integrated-circuit temperature sensor, which is shown

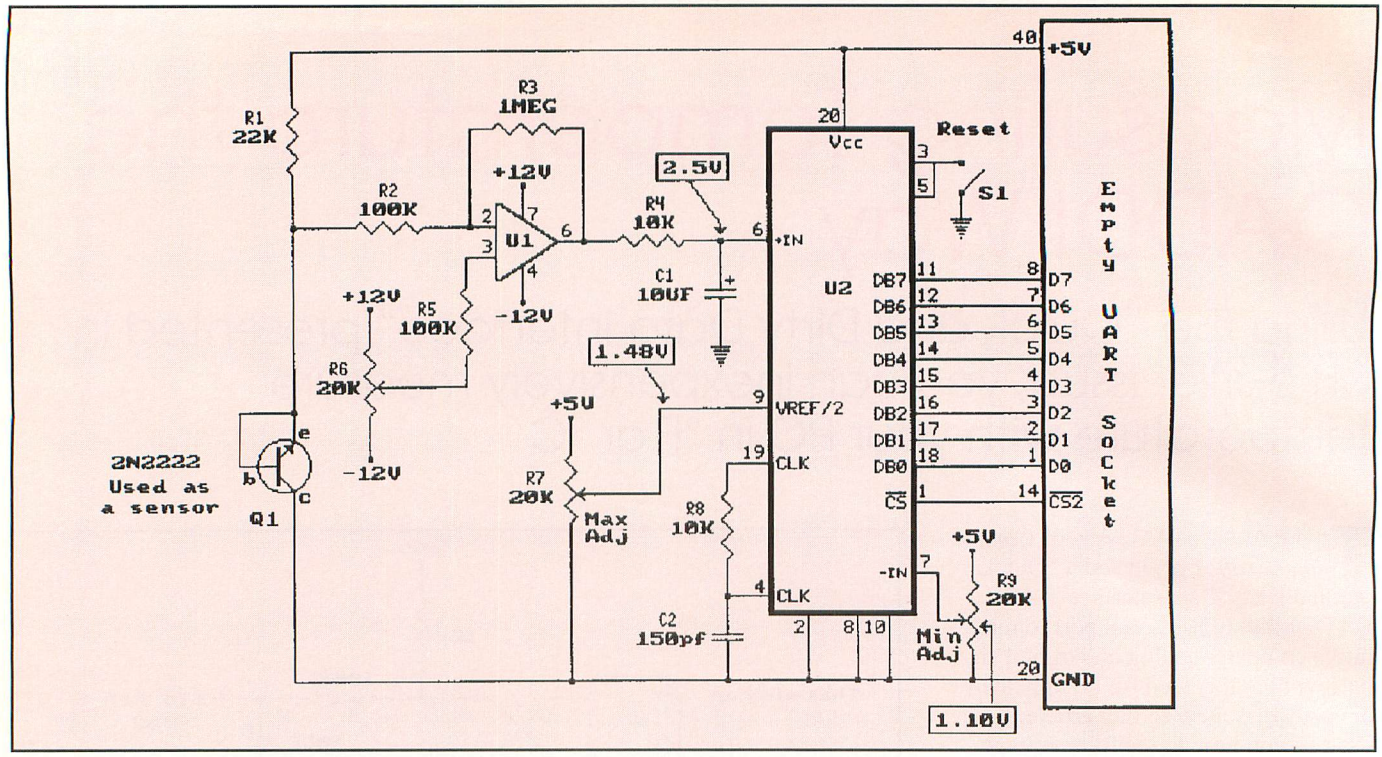


Fig. 3. Complete schematic diagram of circuitry needed to interface a sensor for measuring temperature to a PC via a QADDI interface.

schematically in Fig. 2. This is used as a two-terminal zener device with a breakdown voltage that's directly proportional to temperature. This sensor costs only a few dollars. Opting for it really helps keep wiring to a minimum. The LM335 is shown in the applications notes for the ADC0802 and is a good choice. Being that the LM335 changes by only about 10 mV per degree, adjustment of the A/D converter is a little tricky.

Last discussed here is the thermistor, a device that offers the greatest change per degree. Unfortunately, most commonly available thermistors lack the linearity needed for accurate temperature measurement. If all you want to do is experiment with using your computer as a temperature controller, almost any 1,000- to 100,000-ohm thermistor will work great. If you wish to measure temperature within 1°, I suggest using the diode or IC circuit.

If you've seen thermistors used in projects in the past, they were usually available only from the author. At the time I wrote this article, Radio Shack was selling a precision thermistor. Even though all the ones I bought change resistance the same as any other off-the-shelf thermistor, they aren't linear. A linear thermistor changes resistance by the same amount for each degree of temperature. If it changes 100 ohms per degree, it would go from 10,000 ohms at 70° to 11,000 ohms at 80°.

QADDI Voltage Pinout

Hold the serial card with the edge connector facing down and the component side away from you. The connector contact on the far left is B01, the one on far right B31. It would be a good idea at this point to mark the +12- and –12-volt contacts, which you'll need to power the op amp. These contacts should be connected to circuit-board traces that are wider than other ones on the card. Important contacts for this project on the solder side of the card are as follows:

Contact	Voltage
B1	Ground
B3	+5 volts
B5	–5 volts
B7	–12 volts
B9	+12 volts
B10	Ground
B29	+5 volts
B31	Ground

Several months have passed since the birth of the first QADDI experiment, and the circuits have grown larger. Consequently, you should switch to the following construction technique.

Hold the serial card up to a strong light and examine it with the light passing through, looking for several places where you can drill through the board without slicing through traces. Drill four or more holes that are large enough to comfortably pass through them 2-56 screws, even though only two screws are used at one time.

When you're ready to wire the cir-

PARTS LIST

Semiconductors
Q1—2N2222 npn silicon transistor
U1—741C operational amplifier
U2—ADC0802 analog-to-digital converter

Capacitors
C1—10-µF, 16-volt electrolytic
C2—150-pF ceramic disc

Resistors (1/4-watt, 5% tolerance)
R1—22,000 ohms
R2,R5-100,000 ohms
R3—1-megohm
R4,R8—10,000 ohms
R6,R7,R9—20,00-ohm 10-turn trimmer potentiometer
S1—Normally-open, momentary action spst pushbutton switch

Miscellaneous
Printed-circuit board or perforated board with holes on 0.1" centers and suitable Wire Wrap or/and soldering hardware; sockets for DIP ICs (optional); machine hardware; hookup wire; solder; etc.

Listing 1. BASIC Program for Calibrating Temperature

```
10 CLS
20 T=INP(1016)-20
30 PRINT T:
40 FOR I=1 TO 1000
50 NEXT I
60 GOTO 10
```

cuit, hold the perforated board over the serial card and select two of the many holes in the perforated board that line up the best with two of holes selected on the serial card. Mount the perforated board in place with 2-56 hardware and plastic spacers. Place this assembly in your computer and check for fit. You may have to move around some of the cards that are already in your computer to get to the end slot. It's also a good idea to mark the end of the perforated board that faces up out of the computer. This is where the trimmer potentiometers will mount .

Now remove the perforated board from the serial card but leave the spacers mounted to the perforated board so that you'll be forced to leave room for them during construction.

Even though the sensor might be used for measuring only inside temperature it must be waterproofed to survive the calibration procedure. Solder a 5-foot or longer length of two-conductor stranded wire to the sensor's leads. Since this sensor is polarized, use color-coded wire. A good choice for this purpose is inexpensive speaker wire in which one wire has a stripe on it's insulation or one of the conductors has silver running through it. If you're around any type of magnetic or r-f signals, using shielded wire is a must!

Coat the wire connections to the sensor with epoxy cement and let it set. Then insert the sensor in a 1" section of plastic soda straw and fill with epoxy cement. If you use a transistor as the sensor, coat the connections with epoxy cement and allow it to set. If you have a metal 2N2222 transistor, clip or file off the emitter tab to make the following steps easier.

Coat the assembly with more epoxy cement. This time, before it dries, place a piece of heat-shrinkable tubing over the sensor, exposing only the top half of the transistor. Heat the tubing until it shrinks to its smallest size and clean off any epoxy cement that oozes out. You should now have a waterproof sensor that will respond quickly to temperature.

If you use your QADDI on a port other then COM1, change 1016 (in the software) to one of the following numbers:

Port	Hex	Decimal
COM1	03F8	1016
COM2	02F8	760
COM3	03E8	1000
COM4	02E8	744

You set the serial board so that your computer can see it in the same manner as if it where going to be used for a modem or mouse. Consult the information that came with the serial card you're using.

Calibration

Calibrate your thermometer using the simple BASIC program given in Listing 1. Note that the -20 in line 20 offsets the value read from memory so that you can obtain readings that are below 0° F.

For calibration, use crushed ice with a little water and a large container of 120° tap water. As a third source of reference measure the temperature of the room in which you're working. Use a good mercury thermometer, preferably the type used in photography darkrooms. If you don't have access to such a thermometer, you can use just about any inexpensive one. Just make that sure that it can be immersed in water.

The op-amp transistor circuit requires the trimmer potentiometer at the operational amplifier be adjusted so that you get about 2.5 volts at pin 6 of the A/D converter at room temperature. After doing this, set the MAX ADJ and MIN ADJ potentiometers to the voltages shown in Fig. 3 for a start. Place the sensor in the 120° water and adjust the MAX ADJ limit pot. Then place the sensor in the crushed ice and set the MIN ADJ limit to 32°. Continue moving the sensor back and forth between the 120° water and the crushed ice, allowing several minutes to elapse before touching the adjustment.

As calibration gets better, leave the sensor in the bath of 120° water and crushed ice for longer periods of time. Just keep in mind that the sensor has a settling time based on its mass. A sensor epoxied into a piece of plastic soda straw will take longer to settle than a transistor epoxied in heat-shrinkable tubing with it's top exposed. ■

By Craig S. Stevenson

OS/2 2.1 and High-Speed Communications

A hands-on comparison between OS/2 2.1 and other communications handlers in real-world situations

Consider a 25-MHz 486SX with 8M of RAM and a 245M local hard drive attached to a Novell file server. The mission is to update *DacEasy* Accounting, Payroll, Order Entry, and Point-Of-Sale from floppy disks to a network drive and perform a 14,400-baud Zmodem download to the network drive, in the background, at the same time. This might sound impossible, but it isn't. Using the right combination of hardware and software, this feat can be accomplished using only 20% to 30% of the available computer power. Sound intriguing? If so, read on.

I've been searching for years for a multitasker that could handle high-speed communications. Invariably, there were problems of one sort or another with whatever package I've tried in the past. Many of the problems I encountered were due to the inherent limitations of DOS itself because DOS was never designed to do more than one thing at a time. DOS can certainly handle high-speed communications adequately if this is the only thing it has to do, but when a multitasker, such as *DESQview* or *Windows*, is placed on top of it, things don't work nearly as well.

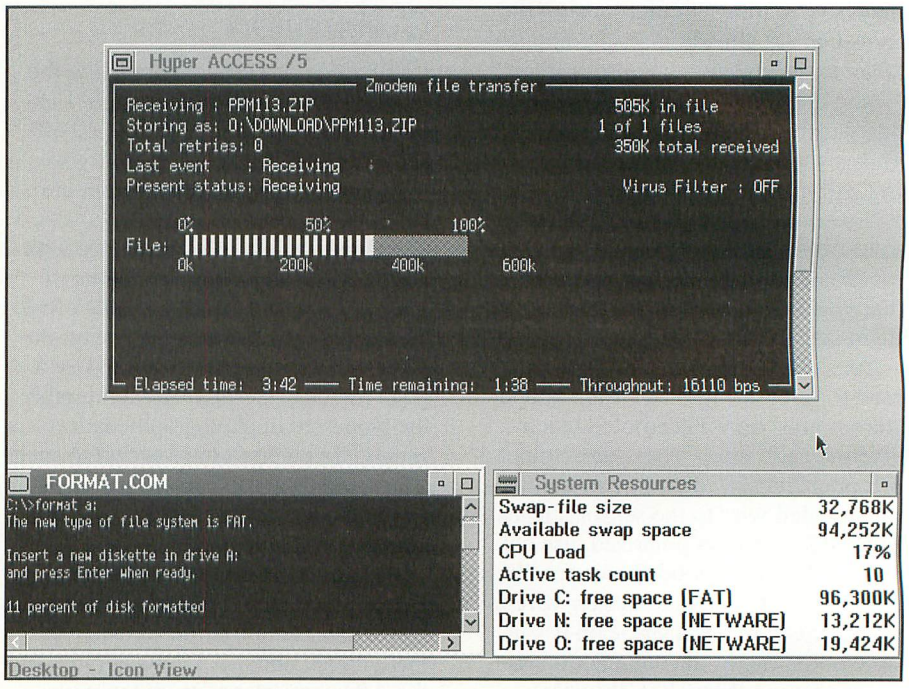


Fig. 1. This screen shows *HyperACCESS/5* downloading a file at 6,611 cps in one session and DOS formatting a floppy disk in another session, using only 17% of the CPU's processing power under OS/2 2.1.

Contenders

Over the years, I've tried a number of packages in my search for the right software package for my particular needs. At times, I've come close, but, in the end, it's been a relatively fruitless search—at least until IBM released its latest version of OS/2. Before getting to OS/2 2.1, however, it's worth seeing how some of the dominant contenders fared.

- ***Windows*** may be the dominant multitasker nowadays, but it's lousy at handling high-speed communications. Because it has a tremendous amount of overhead, interrupts can get locked out for extended periods of time while *Windows* is servicing other tasks. *Windows* 3.1 addressed some of these concerns by reducing overhead and allotting more processor time to communications sessions, but all other applications on the desktop suffer, virtually grinding to a halt. I've seen communications sessions under *Windows* achieve an embarrassing 200 cps (characters per second) on uploads that normally would have exceeded 1,700 cps. To top this off, the whole machine seemed like it was running at a snail's pace, making it impossible to do anything else while a transfer was in progress. To avoid these problems, it was necessary to avoid switching away from the communications session during the file transfer, eliminating the advantage of using a multitasker. My experience has been that in the battle for high-speed communications and effective multitasking, *Windows* isn't even a contender.
- ***DESQview*** has problems similar to those of *Windows*, but since *DESQview*

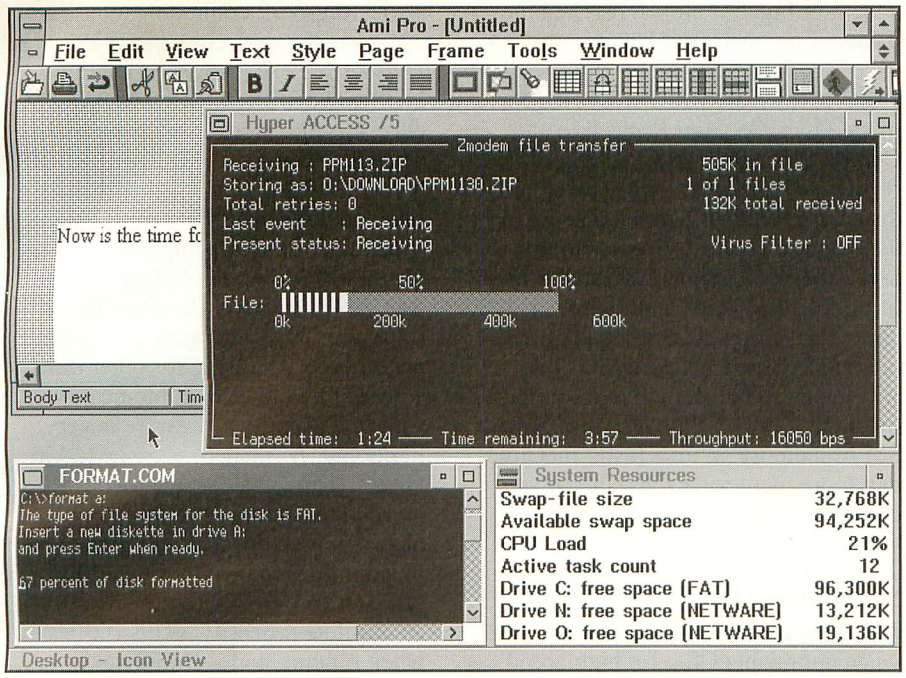


Fig. 2. In this test, OS/2 handled a high-speed communications session, a DOS session (including floppy-drive access) and a *Windows* application simultaneously, with only 21% CPU utilization.

doesn't use a graphical user interface (GUI), the effects are drastically reduced. Actually, *DESQview* does a very credible job of handling high-speed communications and multitasking, given the right hardware, software and a little fine-tuning. Unfortunately, *DESQview* can't run *Windows* applications without loading *Windows* itself, and it has difficulty handling high-resolution graphics. *DESQview* can also exhibit some of the same problems as *Windows* when switching from one task to another. Since interrupts are locked out during a task-switch, file transfer problems can occur here, too.

DESQview/X is able to handle high-resolution graphics better than DESQview, but the increased overhead and dependence on DOS limit its usefulness for serious multitasking of high-speed communications sessions.

DESQview, *DESQview/X* and *Windows* also have problems when attempting to access floppy drives during a communications session. Other applications don't get serviced during the time the floppy drives are being accessed. Since floppy-drive access is a relatively slow process, communications sessions, which require frequent interrupt servicing, suffer the most. So the standard recommendation from technical support is don't access floppy drives during a file transfer.

- ***OS/2***, on paper, has impressive high-speed communications-handling features. When OS/2 2.0 was announced, it sounded like it was tailor-made for my needs. It was supposed to be a better DOS than DOS and a better *Windows* than *Windows*. Special emphasis was placed on its ability to handle high-speed communications. I bought a copy of Version 1.3 (IBM was promising a free upgrade to 2.0 when it was available), and attempted to install it. Because it refused to run on my hardware, I put back on the shelf.

I signed up for the beta test program to get a preview of Version 2.0, but none of the beta versions would run reliably for me. When Version 2.0 was released and I attempted to install it, I had nothing but grief. It wouldn't recognize my mouse, the documentation was poor, it crashed and trashed my hard drive, it was slow and it didn't have support for *Windows* 3.1 applications. So, I put it back on the shelf. When the Version 2.0 service pack came out, I installed it, had nothing but grief and, once again, put OS/2 back on the shelf.

After all my problems with previous versions of OS/2, some might think I am a glutton for punishment. I assure you that I am not. I don't particularly care to wade through 20-some disks only to find out that the program I just installed won't work. Restoring my old system after wasting several hours of my time does nothing to improve my humor. But at the time, I still felt that OS/2 offered me the best chance to accomplish my goals, which were to run DOS, *Windows* and OS/2 applications, and effectively multitask during high-speed communications sessions.

Enter OS/2 2.1

With the arrival of OS/2 2.1, code-named "The Borg," it was time to try once more. I purchased OS/2 on CD-ROM to avoid the incessant floppy swapping required with previous versions. Unfortunately, OS/2 2.1 didn't support my Mitsumi CD-ROM drive. However, there was a utility supplied with OS/2 that could create a set of floppy disks from the CD-ROM, which could be accessed from DOS. I installed OS/2 2.1 successfully and have used it on a daily basis ever since. For me, the true test was how it handled high-speed communications. In a word, it was superb! Once properly optimized, OS/2 2.1 handled high-speed communications better than anything else I've tried. There have been some relatively minor glitches and annoyances, to be sure, but OS/2 2.1 really seems like a solid product this time around.

The example I gave at the beginning of this article was the sequence of events that convinced me that I'd finally found the right operating system. I was testing OS/2 2.1 by downloading a large file in the background using Zmodem. This was a high-speed v.32bis connection (14,400 baud, with ports locked at 38,400 baud), and the transfer rate of the file download was about 1,600 cps. CPU utilization was extraordinarily low (10% to 11%). My company had just received updates to our network *DacEasy* Accounting, Payroll, Order Entry and Point-Of-Sale packages.

I decided to attempt something that had stopped every other multitasker in its tracks: floppy-disk access. I placed the first update disk in my floppy drive, opened a DOS session and started the update. Unbelievably, the download continued without skipping a beat. CPU utilization was only 20% to 30%! I proceeded to update the other three

programs, and the download continued without a hitch. This is an even more-amazing feat when you consider that the downloaded file was being transferred to a network drive and the accounting programs being updated were also located on a network drive. OS/2 2.1 was managing simultaneous access to the network from two separate sessions, along with floppy-drive access and high-speed communications. The Borg, indeed!

To provide visual proof of OS/2 2.1's outstanding multitasking capabilities, I loaded a screen-capture utility to record the results of several tests. To simulate a demanding real-world application, I started *HyperACCESS/5* in a windowed OS/2 session and opened a windowed DOS session. I called a local BBS and initiated a high-speed (v.32bis, 14,400-baud) download using Zmodem. Then I began formatting a 1.44M 3½" diskette in the A: drive. The results of this test are shown in Fig. 1.

Note in Fig. 1 that *HyperACCESS/5* was downloading a file at 16,110 bps (about 1,611 cps) in one session and that DOS is formatting a floppy diskette in another, using only 17% of the CPU's processing power. Also notice that the download was reporting no errors (total retries: 0). Since OS/2 seemed to be handling all of this without a problem, I decided to push a little further. I loaded *Ami Pro* Version 3.0. *Ami Pro* is a *Windows* application that requires extensive computer resources to run. *Ami Pro* was executed in a "seamless" *Windows* OS/2 (WIN-OS2) session, which means that a *Windows* application (*Ami Pro* in this case) can run alongside other applications on the OS/2 desktop. The results of this test appear in Fig. 2.

In this test, OS/2 handled a high-speed communications session, a DOS session (including floppy-drive access) and a *Windows* application at the same time. CPU utilization was 21%. To further prove my point, I decided to add one more application to the mix. Fig. 3 shows the results of my last test.

During the test whose results are shown in Fig. 3, I almost reached the limits of my machine: *HyperACCESS/5* downloading a file at about 1,605 cps, a floppy diskette being formatted by DOS, *Ami Pro* active and Central Point *Backup for DOS* performing a virus scan on my local hard-disk drive. CPU utilization was up to 94% during this test. Even with this level of CPU loading, the transfer rate of the file download hadn't slowed appreciably, and no errors had occurred. This is what multitasking was meant to be! Remember, too, my machine is only a 25-MHz 486SX with 8M of memory. With a faster machine and more memory, even more tasks could be handled effectively.

Optimizing OS/2 2.1

There are several things to consider when optimizing OS/2 for high-speed communications. The first, and probably most important, is choosing the right communications software. A DOS-based communications package can't utilize the full capabilities of OS/2. Normally, I use *QmodemPro*, which is a DOS-based communications package, the finest DOS-based communications package I've used. It works quite well under OS/2 2.1, but it uses 100% of my CPU power to do it. Attempting to allocate less processor time to the *QmodemPro* session results in lost characters or aborted downloads.

After being told that what I needed was a true OS/2 communications package, I purchased a copy of Hilgraeve's *HyperACCESS/5*, which is available in DOS and OS/2 versions. The difference was dramatic, to say the least! The OS/2 version of *HyperACCESS/5* uses 0% of available CPU power at idle and less than 30% during a high-speed file transfer, compared to 100% for the DOS version of *HyperACCESS/5* and *QmodemPro*. This translates into much more processor power being available for other tasks.

In addition to the communications software itself, the hardware is very important. A standard 8250 or 16450 UART (Universal Asynchronous Receiver Transmitter) simply isn't adequate for high-speed communications in a multitasking environment like OS/2. A 16550AFN buffered UART is an absolute necessity. (This is true when running under *DESQview*, *DESQview/X* and *Windows*, and sometimes even under DOS.) The 16550-AFN UART contains a 16-byte first-in, first-out (FIFO) buffer that allows the CPU to temporarily defer processing of the received data. Up to 16 characters can accumulate in the FIFO buffer before requiring service by an interrupt service routine. 8250 and 16450 UARTs have no buffer, requiring that each character be processed before another character is received. If additional characters enter the serial port before the existing characters have been serviced by the computer, the

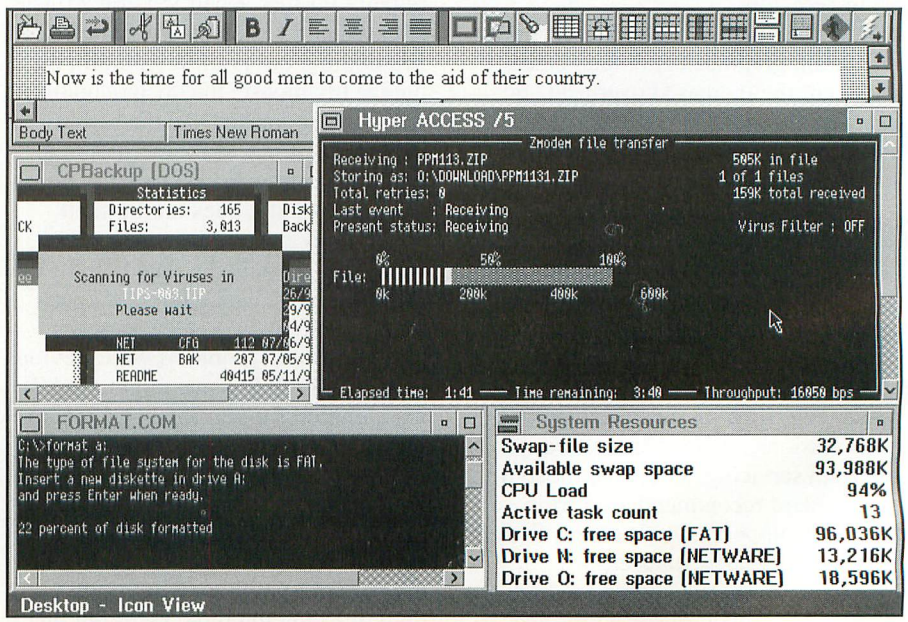


Fig. 3. In this test, *HyperACCESS/5* was downloading a file at about 1,605 cps, a ploffy disk was being formatted by DOS, *Ami Pro* was active and Central Point *Backup for DOS* was performing a virus scan on the local hard drive, upping CPU utilization to 94%, which was almost the limit for the test PC.

new characters overwrite the old ones. This is sometimes referred to as a "data overrun." Symptoms of data overruns include lost characters, garbled screens, aborted downloads and corrupted data. Many difficult-to-diagnose communications problems can be traced back to an inadequate serial port UART.

Even a 16550AFN buffered UART is no guarantee that communications problems will disappear when operating under a multitasker. Despite the fact that the 16550AFN contains a 16-byte buffer, characters are still transferred to the computer one byte at a time. If the interrupt service routines are delayed long enough by other processes, characters will be lost. High-speed modems can fill the 16-byte buffer to capacity in a fraction of a second, making timely interrupt servicing an absolute necessity. This is a critical factor when multitasking a number of programs that require extensive CPU resources. Since all processes compete for a limited amount of CPU time, the communications session may not be able to get the amount of attention from the CPU required to ensure error free data transmission and reception.

Another consideration when operating under a multitasker is the amount of CPU loading. Each running process (program) requires a certain amount of attention from the CPU. The more processes running simultaneously, the greater the CPU load. If the CPU gets overloaded, all processes must wait for servicing. To a word processor or spreadsheet, this means the screen won't update as quickly or a calculation will take longer than usual to complete. To a communications program, might result in lost characters, garbled screens or corrupted data. To minimize the CPU load, each program should be optimized to reduce its impact on overall system performance.

The ultimate solution to data-overrun and CPU-loading problems for communications sessions is the Hayes ESP (Enhanced Serial Ports) board. Three modes of operation are available with this board. Original Compatibility mode emulates a 16450 UART. FIFO Enhanced mode uses 16550AFN UARTs to provide 16-byte FIFO buffering. DMA Enhanced mode uses the ESP's on-board communications coprocessor to handle serial-port data buffering of up to 1,024 characters.

Table 1. HyperACCESS/5 (OS/2 Version)

USR v.32bis (14,400-Baud Connection, Port Locked at 38,400 Baud)

Communications Driver	CPU Usage at Idle	CPU Usage During Download	Characters Per Second
COM.SYS	0%	22% to 30%	1,600
SIO.SYS	0%	13% to 22%	1,600
ESP220.SYS	0%	7% to 11%	1,600

DMA Enhanced mode also uses the ESP's microprocessor and memory to provide high-speed data transfers using one of the DMA (Direct Memory Access) channels within the computer. This permits data to be transferred in large blocks (up to 1,024 bytes) directly to the computer's memory, completely bypassing the CPU. This block data transfer occurs on a single processor interrupt, substantially reducing CPU load and increasing throughput.

There have been several upgrades to the ESP board. So if you choose to utilize DMA Enhanced mode, make certain that you have the latest firmware upgrades and are using the OS/2 ROM. The ESP board also requires ESI (Enhanced Serial Interface) software support, either in the DOS application itself or via the Hayes-supplied communications device driver ,when used with an OS/2 application. The OS/2 version of *HyperACCESS/5* is able to use the DMA Enhanced mode through the Hayes device driver.

For the serial port hardware to operate in combination with OS/2, communications device drivers are required. OS/2 2.1 provides two communications device drivers. COM.SYS is the OS/2 session communications device driver. VCOM.SYS is the communications device driver for DOS and *Windows* sessions. These drivers are adequate, but substantial improvement is possible by using a set of shareware OS/2 communications drivers called SIO.SYS and VSIO.SYS. These drivers reduce the overhead associated with high-speed communications, allowing more CPU time for other tasks. The Hayes ESP board uses a communications device driver called ESP220.SYS. Differences in overhead during a high-speed Zmodem download are shown in Table 1. During this test, *HyperACCESS/5* was the only application running on the OS/2 desktop.

As Table 1 shows, SIO.SYS can reduce the CPU load by 50%. The Hayes ESP board used in combination with ESP220.SYS can reduce the CPU load by about 30%, compared to the standard OS/2 communications device drivers.

Although somewhat daunting at about 75 lines, the OS/2 CONFIG.SYS file contains some settings that can affect high-speed communications. Some changes I made to my CONFIG.SYS file to improve high-speed communications are as follows:

```
PRIORITY_DISK_IO=NO
MAXWAIT=2
```

The PRIORITY_DISK_IO setting determines whether applications running in the foreground have priority access to disks. The default setting is PRIORITY_DISK_IO=YES. Since a communications session will likely run in the background, setting PRIORITY_ DISK _ IO = NO gives the communications session equal access to the disks. The MAXWAIT command sets the longest period of time a program will have to wait to execute before OS/2 raises its priority. This prevents one program from being put on hold forever while another program consumes all of the processor's power. The default setting is MAXWAIT=3, which corresponds to 3 seconds. A setting of 2 or 1 is preferred for high-speed communications occurring in the background.

Recommendations

My recommended minimum OS/2 2.1 system would be a 25-MHz 486SX with 8M of RAM, a 170M hard drive and a fast VGA or SVGA video card. OS/2 will run on systems with less

horsepower than this, but the results will probably not be acceptable. After using OS/2 2.1 for several months, I'm convinced that more memory would make the greatest performance difference for most users. OS/2 2.1 does a substantial amount of swapping to disk, and extra memory will permit a larger disk cache, in addition to more available memory for OS/2 itself. I plan to upgrade to 16M of RAM as soon as possible.

Obviously, a faster microprocessor would also help, along with an accelerated video card. Support for accelerated video cards has been slow in arriving, but this situation is changing.

For high-speed communications, I recommend at least a serial port with a 16550AFN UART, combined with an OS/2 communications package. SIO /VSIO drivers are clearly useful in reducing overhead when compared to the standard OS/2 2.1 communications device drivers. The ultimate system would include a Hayes ESP serial card using DMA Enhanced mode.

OS/2 2.1 is clearly the best multitasker available today for those who need to multitask during a high-speed communications session. The ability to reliably access floppy drives, networks and other applications during a file transfer improves productivity. Even though I'm not a *Windows* fan, OS/2 allows me to use a couple of *Windows* programs I like and still offers superior handling of DOS and OS/2 applications. Another benefit of using OS/2 is that third-party memory managers or disk caches are no longer necessary, since OS/2 2.1 provides these services.

It has been a long, hard road, but after years of searching, I've finally found the operating system I was looking for. OS/2 is no longer sitting on the shelf collecting dust. Instead, *DESQview*, *DESQview/X* and *Windows* are on the shelf—where they'll likely remain. ■

Products Mentioned

SIO/VSIO Drivers
Raymond L. Gwinn
12469 Cavalier Dr.
Woodbridge, VA 22192
Fax: 703-494-0595

CIRCLE NO. 111 ON FREE INFORMATION CARD

Hayes ESP Serial Card
Hayes Microcomputer Products
6610 Bay Cir.
Norcross, GA 30071
Tel.: 404-840-9200

CIRCLE NO. 112 ON FREE INFORMATION CARD

HyperACCESS/5
Hilgraeve Inc.
P.O. Box 941
Monroe, MI 48161
Tel.: 313-243-0576

CIRCLE NO. 113 ON FREE INFORMATION CARD

OS/2 Version 2.1
International Business Machines Corp.
IBM Fulfillment Headquarters
PO Box 525
Dearborn, MI 48121-0525
Tel.: 800-342-6672

CIRCLE NO. 114 ON FREE INFORMATION CARD

Windows 3.1
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052-6399

CIRCLE NO. 115 ON FREE INFORMATION CARD

QmodemPro Version 1.50
Mustang Software, Inc.
PO Box 2264
Bakersfield, CA 93303
Tel.: 805-395-0223

CIRCLE NO. 116 ON FREE INFORMATION CARD

DESQview and DESQview/X
Quarterdeck Office Systems
150 Pico Blvd.
Santa Monica, CA 90405-9852

CIRCLE NO. 117 ON FREE INFORMATION CARD

By Nick Goss

Build a Real-World Work Robot

Part 5

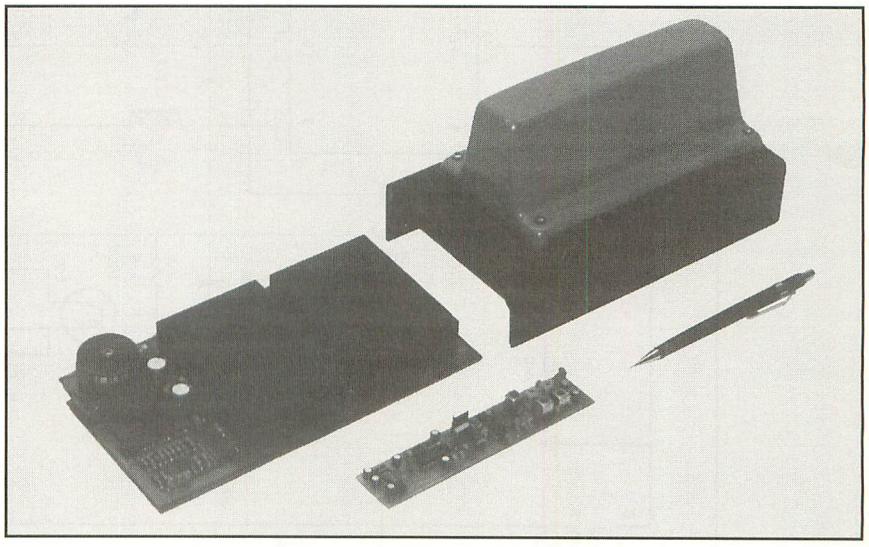
Adding a simple device that lets you send and receive RS-232 serial data directly over an FM modem communication link

If you've been building the RONAR (Remotely Oriented Numerically Actuated Robot) project I've discussed in the last four issues of *ComputerCraft*, you should be at the point where you're ready to add the Poly-Link r-f modem, the r-f transmitter and receiver portions of which are the subject of this installment. Having a bidirectional wireless data link between your host computer and RONAR is an important asset, particularly when you plan to use the robot for practical work.

Although the transmitter/receiver project described here was specifically designed to be used with the RONAR robot, you'll find that it also lends itself well to a wide range of data-communications applications. Because this system is modular, inexpensive and easy to build, it will provide you with an excellent price/performance ratio. Furthermore, because the device is inexpensive and spectrum-efficient, you're free to experiment with QSS (quasi-spread-spectrum) communication channels that utilize multiple Poly-Link transmitters.

The Poly-Link system lets you control remotely-located events and lets you receive real-time "back-channel" information. By attaching a separate transmitter to each serial port on a host PC, you can send and receive full-duplex data messages simultaneously, which is an ideal solution to multitasking and distributed-processing rolled into one.

Although many possible communication protocols are available for use with the Poly-Link system, I leave the message structure, FEC (forward error correction) algorithms, etc., to you. You can consult any of the many excellent books available on communications channel theory and error-correction techniques to get yourself going in these areas. I suggest that you design a message format that suits your particular application.



About the Circuit

Perhaps the easiest way to understand how this radio communication system works is to examine the receiver and transmitter circuitry separately. Once you know the theory of operation of each unit, it's a relatively easy process to integrate what you know to understand how the entire system works.

· ***Transmitter.*** Shown in Fig. 1 is the schematic diagram of the Poly-Link transmitter. RS-232C data to and from the host PC or microcontroller is conditioned and level-shifted by MAX-232 interface *U4*, which internally converts the ±12-volt RS-232C level signals to their inverted +5-volt TTL counterparts. Pin 9 provides microcontroller *U1* with the data to be transmitted to the remotely-located Poly-Link receiver.

As data is received at *U1*, a back-channel or "echo" data stream is returned to the host computer via pin 10. Although it isn't necessary in normal communication modes, echo data can be useful in certain applications.

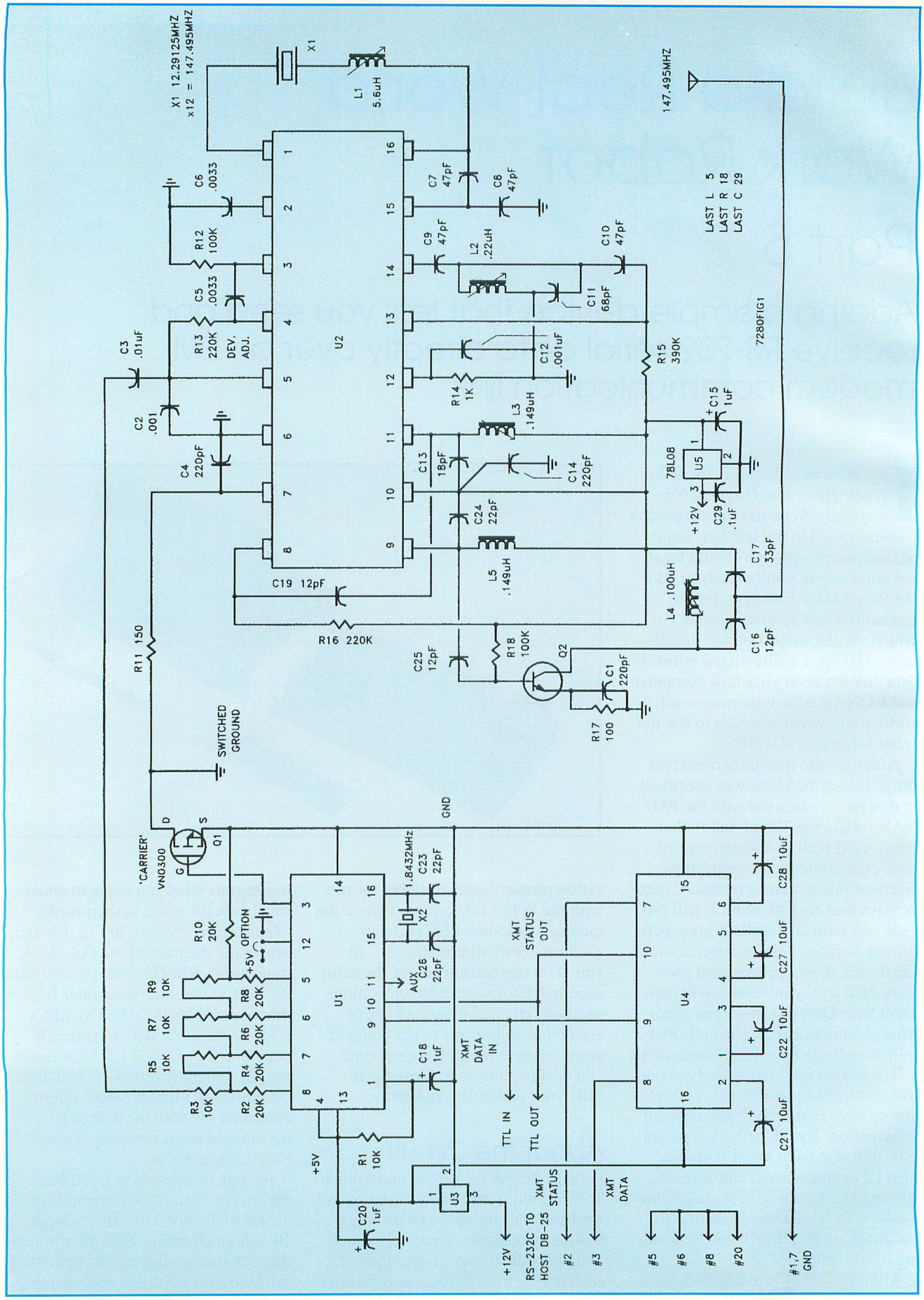

X1 12.29125MHZ
x12 = 147.495MHZ
X1
L1
5.6uH
147.495MHZ
C6
.0033
C7
47pF
C8
47pF
R12
100K
C9
47pF
L2
.22uH
C10
47pF
C5
.0033
R13
220K
DEV.
ADJ.
C11
68pF
C3
.01uF
U2
C12
.001uF
R15
390K
C2
.001
R14
1K
L3
.149uH
C15
1uF
C4
220pF
C13
18pF
C14
220pF
7BL08
U5
C24
22pF
+12V
C29
.1uF
C17
33pF
L5
.149uH
C19 12pF
L4 .100uH
R16 220K
C16
12pF
R11 150
C25
12pF
R18
100K
Q2
C1
220pF
R17
100
SWITCHED
GROUND
'CARRIER'
VN0300
Q1
D
G
S
GND
1.8432MHz
C23
22pF
X2
C26
22pF
AUX
R10
20K
OPTION
+5V
R9
10K
R8
20K
R7
10K
R6
20K
R5
10K
R4
20K
R3
10K
R2
20K
U1
XMT
STATUS
OUT
C18
1uF
XMT
DATA
IN
TTL IN
TTL OUT
+5V
R1
10K
U3
U4
C28 10uF
C27 10uF
C22 10uF
C21 10uF
C20
1uF
+12V
RS-232C TO
HOST DB-25
XMT
STATUS
XMT
DATA
#2
#3
#5
#6
#8
#20
#1,7
GND
LAST L 5
LAST R 18
LAST C 29
7280FIG1

Fig. 1. Complete schematic diagram of the transmitter circuitry.

TRANSMITTER PARTS LIST

Semiconductors
Q1—VN0300 hexFET transistor
Q2—2N3700 npn silicon transistor
U1—MC68HC705K1 microcontroller (pre-programmed)
U2—MC2833 r-f transistor
U3—78L05 fixed +5-volt regulator
U4—MAX-232CP RS-232C interface
U5—78L08 fixed +8-volt regulator

Capacitors
C1,C4,C14—220-pF, 50-volt ceramic disc
C2,C12—0.001-µF, 50-volt ceramic disc
C3—0.01-µF, 50-volt ceramic disc
C5,C6—0.0033-µF, 50-volt ceramic disc
C7 thru C10—47-pF, 50-volt ceramic disc
C11—68-pF, 50-volt ceramic disc
C13—18-pF, 50-volt ceramic disc
C15,C18,C20—1-µF, 16-volt electrolytic
C16,C19,C25—12-pF, 50-volt ceramic disc
C17—33-pF, 50-volt ceramic disc
C21,C22,C27,C28—10-µF, 16-volt electrolytic
C23,C24,C26—22-pF, 50-volt ceramic disc
C29—0.1-µF, 50-volt ceramic disc

Inductors (5-mm form-wound)
L1—5.6-µH adjustable
L2—0.22-µH adjustable
L3,L5—0.149-µH adjustable
L4—0.100-µH adjustable

Resistors (1/4-watt, 5% tolerance)
R1—10,000 ohms
R11—150 ohms
R12,R18—100,000 ohms
R13,R16—220,000 ohms
R14—1,000 ohms
R15—390,000 ohms
R17—100 ohms
R2,R4,R6,R8,R10—20,000 ohms, 1/8-watt
R3,R5,R7,R9—10,000 ohms 1/8-watt

Miscellaneous
X1—12.29125-MHz crystal
X2-1.8432-MHz crystal
Printed-circuit board (see text); suitable enclosure; 144-to-148-MHz antenna; 4-40 x 3/8" threaded spacers; RG-174U coaxial cable (see text); 4-40 x 1/4" pan-head Phillips screws; hookup wire; solder; etc.

Note: The following items are available from Cyance Kit, 14786 Slate Gap Rd., West Fork, AR 72774 (tel.: 501-839-8293 voice or 501-839-8221 fax): 12.29125-MHz crystal $10.95; 1.8432-MHz crystal $4.95; programmed MC-68HC705K1, $9.95 (include call-sign for IDer); complete Poly-Link transmitter kit with printed-circuit board, all ICs and other components but *not* antenna, $49.95. Please add $4.89 for insured S&H. MasterCard, Visa, check or COD welcome.

Chip *U4* utilizes internal charge-pump circuits made up of electrolytic capacitors *C21*, *C22*, *C27* and *C28*. These capacitors make it possible for *U4* to synthesize positive and negative output voltages that are much greater in potential than the +5-volt supply.

Data encoder *U1* is a pre-programmed microcontroller that utilizes crystal *X2* to provide a stable time-base from which to generate the various mark and space tones that form the FFSK (fast frequency-shift keyed) modulator signals. As transmit data is collected from the host computer, *U1* formats a message that typically consists of a "herald," "Barker Code," message body and a polynomial FEC (forward error-correction) code BCC (binary cyclic code).

Data stored in RAM internal to *U1* is converted directly into FFSK tones via a simple algorithm. The algorithm provides a continuous phase shift at the mark and space transitions and is particularly efficient and easy to code.

Resistors *R2* through *R10* make up an R-2R ladder network that directly converts the binary output of *U1*'s four-bit port into an analog voltage. Touching the probe of an oscilloscope to the output side of *R3* when *U1* is transmitting, you'll observe a frequency-modulated (FM) sine wave in the audio spectrum.

Resistor *R1* and capacitor *C18* make up a power-on reset circuit function, and field-effect transistor *Q1* provides PTT (push-to-talk) carrier-on switching action. Chip *U1* controls *Q1* and pulls the data transmitter section's switched-ground line to ground only when transmitting is actually taking place. This carrier-controlled approach to transmitter operation minimizes power consumption and reduces possible inter-channel r-f interaction.

FFSK data signals are applied to vhf transmitter *U2* through dc-blocking capacitor *C3*. Capacitor *C2* removes high-frequency switching-noise introduced by the crude D/A converter network. Resistor *R13* sets the deviation of *U2* to about 3.5 kHz. It may need adjustment to suit your particular application. FCC rules and regulations strictly control the deviation of narrow-channel FM transmitters and prohibit deviation of more that 4.5 kHz.

Crystal *X1*, inductor *L1* and the internal circuitry available at pins 1, 15 and 16 of *U2* comprise the fundamental r-f oscillator. The crystal puts the operating frequency in the 2-meter telemetry band. Since values for the various capacitors and inductors in the *U2* circuit are critical, you're advised against substituting components here. The capacitors and coils at pins 14 through 11 of *U2* buffer the oscillator signals as they double and triple the carrier frequency by amplifying the upper harmonics of *X1*.

A final frequency-doubling and power-output stage is formed by *U2*'s internal r-f transistor, working in conjunction with *Q2* and associated resistors, capacitors and coils. Each stage in the carrier-synthesis process is tuned via *L2* through *L5*. The power amplifier and antenna coil *L4* are tuned for optimum output with a whip or ground-plane antenna.

Power for *U1* is regulated from the 12-volt dc system supply by fixed +5-volt regulator *U3*. Likewise, fixed +8-volt regulator *U5* supplies *U2*.

In normal operation, +8 volts is supplied to *U2* and its associated circuitry at all times. When *U1* needs to transmit a message, *Q1* pulls the ground bus of the transmitter down from the V+ rail to near ground potential. This makes sophisticated LBT (listen-before-talk) protocols workable and easy to implement in software.

• ***Receiver.*** The schematic diagram of the receiver is shown in Fig. 2. In its simplest form, the receiver's antenna can be a length of wire of about 19" at the 144-MHz operating frequency of the system.

R-f signals present at the antenna induce micro-currents that couple through *C1* into the tuned circuit made up of *L1* and *C2*. You tune *L1* to obtain peak signal at the exact operating frequency. Capacitor *C2* injects the incoming r-f signal directly into the base of *U1*'s internal r-f transistor at pin 2. The r-f signal is amplified by the internal device and applied to the tuned circuit made up of *R2*, *L2* and *C5*. Again, *L2* must be tuned to peak the r-f signal level at the operating frequency.

Once amplified and filtered, the r-f signal is coupled by *C4* into the first mixer at pin 1 of *U1*. Mixing the incoming r-f signal with the output of the first local oscillator, the frequency-determining elements being *R1*,

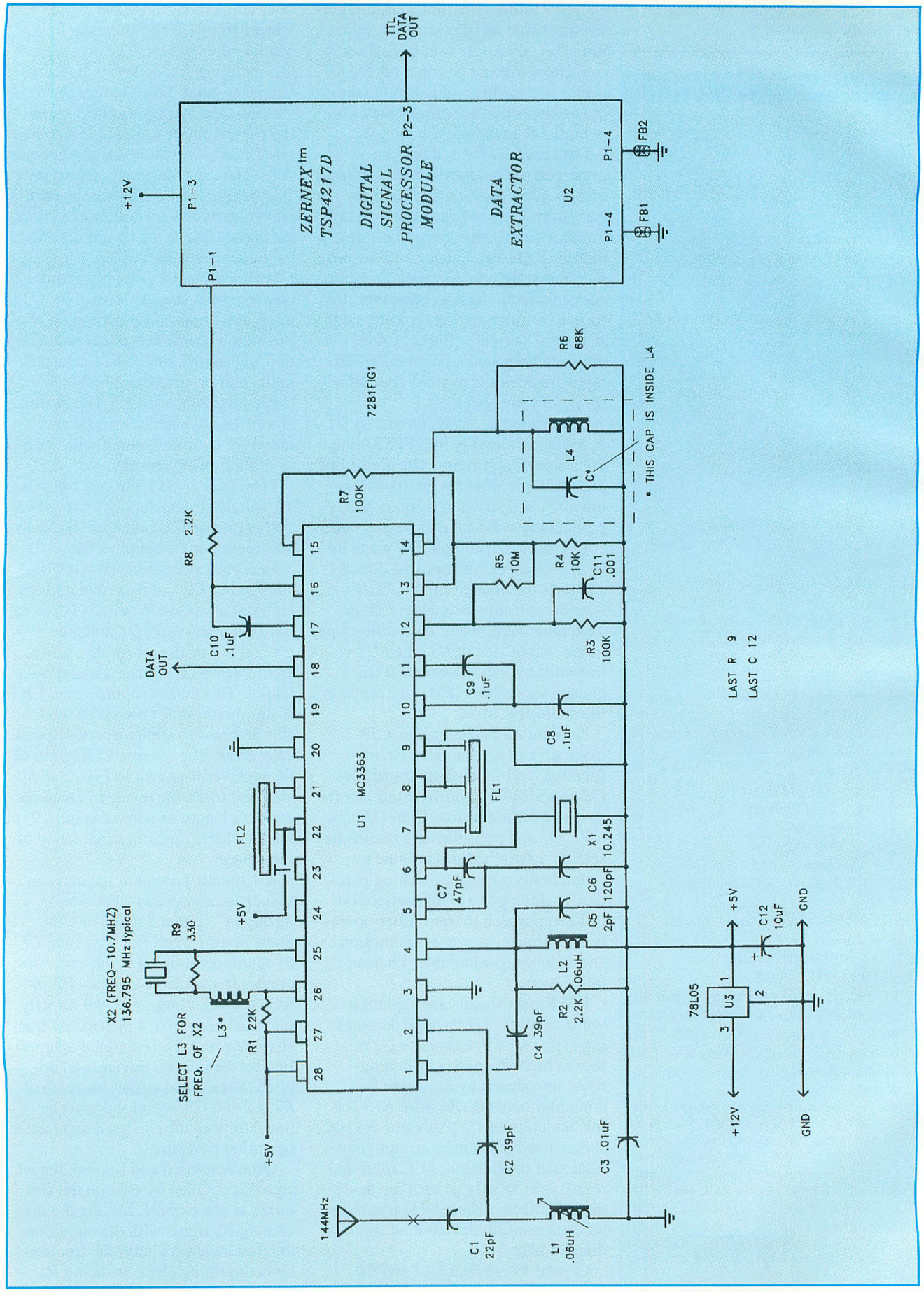

ZERNEX tm
TSP4217D
DIGITAL SIGNAL PROCESSOR MODULE
DATA EXTRACTOR
U2
P1-1
P1-3
P1-4
P2-3
+12V
TTL DATA OUT
FB1
FB2
U1 MC3363
7281FIG1
DATA OUT
R1 22K
R2 2.2K
R3 100K
R4 10K
R5 10M
R6 68K
R7 100K
R8 2.2K
R9 330
C1 22pF
C2 39pF
C3 .01uF
C4 39pF
C5 2pF
C6 120pF
C7 47pF
C8 .1uF
C9 .1uF
C10 .1uF
C11 .001
C12 10uF
L1 .06uH
L2 .06uH
L3*
L4
C*
• THIS CAP IS INSIDE L4
FL1
FL2
X1 10.245
X2 (FREQ-10.7MHZ) 136.795 MHz typical
SELECT L3 FOR FREQ. OF X2
144MHz
+5V
GND
U3 78L05
LAST R 9
LAST C 12

Fig. 2. Complete schematic diagram of the receiver circuitry.

RECEIVER PARTS LIST

Semiconductors
U1—MC3363 FM receiver
U2—Zernex TSP-4217D digital signal processor
U3—78L05 fixed +5 volt regulator
Capacitors
C1—22-pF, 50-volt ceramic
C2,C4—39-pF, 50-volt ceramic
C3—0.01-F, 50-volt ceramic
C5—2-pF, 50-volt ceramic
C6—120-pF, 50-volt ceramic
C7—47-pF, 50-volt ceramic
C8,C9,C10—0.1-F, 50-volt ceramic
C11—0.001-F, 50-volt ceramic
C12—10-F, 16-volt electrolytic
Resistors (1/4-watt, 5% tolerance)
R1—22,000 ohms
R2,R8—2,200 ohms
R3,R7—100,000 ohms
R4—10,000 ohms
R5—10,000,000 ohms
R6—68,000 ohms
R9—330 ohms
Miscellaneous
FL1—455-kHz ceramic r-f filter
FL2—10.7-MHz ceramic r-f filter
X1—10.245-MHz crystal
X2—136.795-MHz fundamental crystal
L1,L2—0.060-H adjustable 5-mm coil
L3—0.22-H adjustable 5-mm coil
L4—No. 6597 7-mm adjustable quad coil
FB1,FB2—1/8" x 0.100" ferrite bead
Printed-circuit board; sockets for DIP ICs; suitable enclosure; machine hardware; hookup wire; solder; etc.
Note: The following items are available from Cyance-Kit, 14786 Slate Gap Rd., West Fork, AR 72774 (tel.: 501-839-8293, Ext. 3 for voice or 501-839-8293 for fax): surface-mount MC3363, $9.95; ready-to-wire printed-circuit board, $9.95; complete kit with board and all components (except *X2* and *U2*), $49.95. Also available separately are *X2* (136.795-MHz) for $19.95 and *U2* for $69.95. Add $4.89 for insured UPS S&H. MasterCard/Visa, check or COD welcome. Arkansas residents, please add state sales tax.

L3, *R9* and *X2*, creates a composite r-f output. The lower side of this output signal is very close to 10.7-MHz. (The frequency of *X2* is exactly 10.7 MHz below the actual operating frequency.)

The output of the first mixer is available at pin 23 of *U1*, where it's filtered by ceramic filter *FL2*. The filter's output is routed back to pin 21 of *U1*, where it's internally applied to the second mixer. A second local oscillator whose frequency-determining elements are *X1*, *C6* and *C7* outputs a signal that's also applied to the second mixer and combined with the 10.7 MHz r-f input at pin 21.

The 455-kHz signal at pin 7 is filtered by *FL1* and applied to the i-f amplifier strip at pin 9 of *U1*. The output at pin 13 of *U1* is applied to quadrature coil *L4*, where the FM signal is discriminated (recovered) back into baseband audio. Unfiltered audio signals at pin 16 are routed to DSP *U2* through *R8*. Capacitor *C10* also applies the recovered baseband audio to the internal data-separator circuit in *U1*. Although it's very susceptible to r-f noise, data-output pin 18 can be useful in short-range work.

Chip *U2* automatically scans incoming signals for valid FFSK data signals. The sophisticated, on-board search-and-extract firmware algorithm cleans up the original message data and outputs it in TTL form at pin 3 of *P2*. If you plan to couple the TSP4217D directly into an RS-232C serial port on your PC, you'll have to add a MAX-232 converter to level-shift the signals.

Small ferrite-beads *FB1* and *FB2* are used to ground *U2*. These beads are important because they trap vhf signals that might otherwise affect the receiver's input sensitivity.

Construction

I'll handle construction details separately for the transmitter and receiver assemblies. Before you begin construction of the transmitter portion of this project, however, you must have a valid Communicator Class or better license. (See the "Poly-Link, You and the Law" box elsewhere in this article for details.)

Begin construction of the transmitter and receiver modules by fabricating the printed-circuit boards, using the full-size artwork provided in Fig. 3. If you don't care to fabricate your own pc boards, you can obtain ready-to-wire ones from the source given in the Note at the end of the Parts Lists. If you make your own boards, use a No. 68 drill bit for the small holes and at least a No. 62 bit for the larger holes. Work carefully with these small bits, and be sure to wear safety glasses.

• ***Transmitter.*** Begin populating the transmitter board with the resistors and capacitors, referring to Fig. 4. Use the exact values given in the Transmitter Parts List because they're critical to proper operation of the transmitter. If you don't have a good source for the various components, including the 5-mm coils and inductors, you can get them from the same source mentioned above.

As you can see in Fig. 5, some resistors mount vertically to save space on the board and shorten the r-f signal paths across the card. Be very careful with the small ceramic and silver-mica capacitors. It's very easy to split or break the fragile component bodies when forming the leads.

When installing *R5*, *R7* and *R9*, solder directly to one of the leads on *R4*, *R6* and *R8*. Determine which end of the resistor to install in the down position. Work through the stuffing sequence of the R-2R network before actually soldering any of the components into place.

Next, mount the coils and inductors. Again, be very careful to avoid breaking the coilform cases. Solder the devices carefully, and watch for overheating. Too much heat on some coils could unsolder the tiny coil wires from the binding posts. If this occurs, the coil will be ruined.

Finally, install the crystals, transistors and ICs. Owing to the r-f nature of this circuit, do not use sockets for the DIP ICs. Install and solder them directly into place. As you install the ICs, make certain that each goes in its proper location and is properly oriented before soldering it into place.

• ***Receiver.*** When building the receiver, exercise care with these r-f vhf circuits. Printed-circuit construction is the *only* way to go. I've used a single-sided printed-circuit board for this project, as illustrated in Fig. 3. There's no need for a double-sided board here, with the top serving as a ground plane for the circuit.

Before you begin populating the board according to Fig. 6, take note that *U1* is a surface-mount chip and that it must go on the solder or foil side of the board. Similarly, the ferrite beads mount on the solder side.

Begin populating the board by installing and soldering into place the

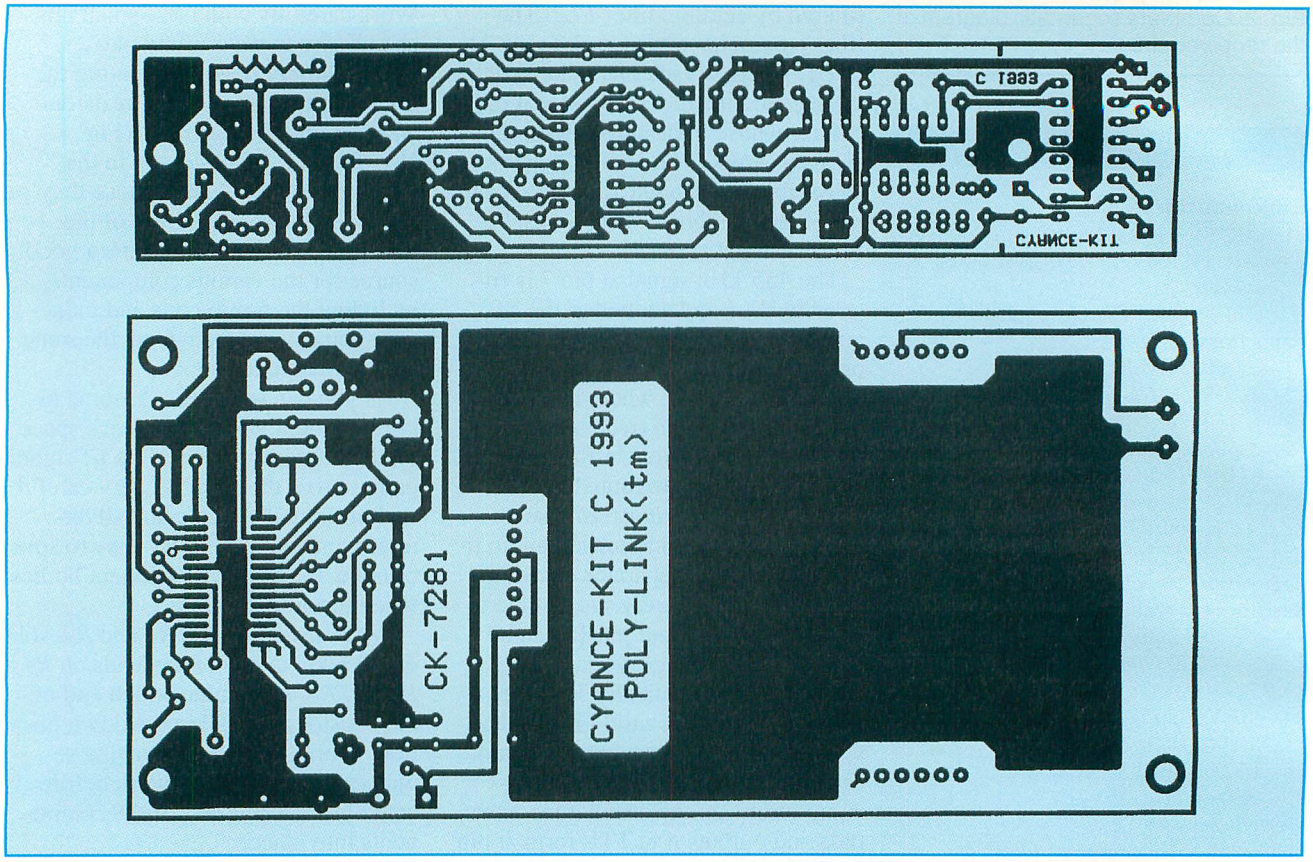


Fig. 3. Actual-size etching-and-drilling guides for fabricating (A) the transmitter and (B) receiver printed-circuit boards needed for this project.

resistors and capacitors. Keep your work neat and be sure to double-check yourself frequently against Fig. 2 and Fig. 6. The values listed for the receiver were carefully chosen to yield proper operation. Therefore, do *not* substitute components or values!

Now install the coils. Be very careful with the coilform leads, which are very easy to break. Make sure that the forms stand perpendicular to the board before soldering them into place. Then install the ceramic filters and crystals.

Very carefully solder surface-mount *U1* into place. Soldering such a small device perfectly into place is a tedious job. Unless your eyesight is excellent, I recommend that you use a magnifying-light or stereo microscope to aid in soldering. Because installing *U1* is fairly tricky, the source listed in the Note at the end of Parts List has a version of the ready-to-wire PC board with the IC already installed on it.

If you decide to mount *U1* yourself, make sure you use a fine-point soldering iron and thin-strand solder. Begin by flowing a *small* bit of solder at the four corner pads for *U1* on the pc board (solder side, remember). The solder should melt and flow across the entire pad to form a thin layer over the copper foil. Make certain that it doesn't bridge to any nearby copper traces.

Next, using very small longnose pliers or tweezers, orient *U1* with pin 1 matching the artwork pin 1 flag. As you hold the IC in place with one hand, touch the tip of the soldering iron to one of the corner pins to heat it. When the pin is hot enough, the solder should flow up from the board pad and onto the IC lead to temporarily tack this lead in place. Do the same with the lead on the diagonally opposite corner and then with the leads at the two remaining corners. Wait 10 seconds or so between solder operations to allow the chip to cool.

Slowly and carefully heat each lead and flow a tiny bit of solder to form a good electrical and mechanical bonds. With the IC firmly secured at the corners, solder each of the remaining leads of the IC to its respective trace on the pc board. Then clean the IC and surrounding pads to remove all traces of solder flux that can greatly affect circuit performance.

Install 78L05 voltage regulator *U3* and the two ferrite beads, sliding solid bare No. 22 hookup wire through the beads and soldering the wires into place. Finish up by soldering *U2* onto the board. Photos of the fully-wired receiver assembly are shown in Fig. 7.

While experimenting with the system, you may want to leave the receiver and transmitter PC boards out of whatever enclosures you plan to use to house them. When you've finished conducting preliminary tests and are satisfied that the two units are in proper operating order, mount them inside metal enclosures to prevent stray r-f fields from affect the system's performance.

Checkout & Calibration

To test the transmitter, temporarily connect a 9-volt battery via a standard snap-type clip to the circuit-board assembly at the points labeled +12V

Poly-Link, You and the Law

To legally use the Poly-Link project described in the main article, you must obtain a Communicator Class or better license from the Federal Communications Commission (FCC). In fact, you're legally bound to obtain the proper license even before you actually build the project.

Even though Poly-Link is a low-power data transceiver, it's designed to operate in the 2-meter amateur radio band. The FCC has established a special class of amateur radio license that permits you to experiment with devices like Poly-Link.

To obtain the required license, simply contact an amateur radio operator if you know one or a local ham club (you'll find any in your local area listed in the telephone directory) if you don't, and take the 25-question multiple-choice question test. Since the answers to the questions on this test are given to you ahead of time, there should be no reason not to pass the simple test on the first try!

Once you have the appropriate FCC license, you're free to bring your Poly-Link "on-line." If you wish to operate your Poly-Link at other frequencies (VHF-II Commercial Band), simply contact your local FCC office and obtain an appropriate site license.

Don't even think about operating your Poly-Link or any similar device without first obtaining a license to do so. If you do and get caught, the fines are steep.

(red lead) and GND (black lead). If you have an r-f dummy load, connect it between the ANT and ANT GND pads, using about a 1-foot length of RG-174U coaxial cable.

If you plan to use your Poly-Link system with a host computer, wire a DB-25 connector to the transmitter board per the details given at the lower-left in Fig. 1. Notice that four connector pins must be connected in common to force your host's RS-232C port to ignore *U1*'s status and simply dump ASCII data directly into pin 9 of *U1*.

Connect a dc voltmeter or multimeter set to the dc-volts function or the probe of an oscilloscope to pin 13 of *U1*. Then, observing proper polarity, briefly touch the terminals of a 9-volt battery to the snaps on the clip connected to the board while observing the activity at pin 13 of *U1*. (I say "touch" because you want only an instantaneous reading on your meter or scope.) If you fail to obtain a reading

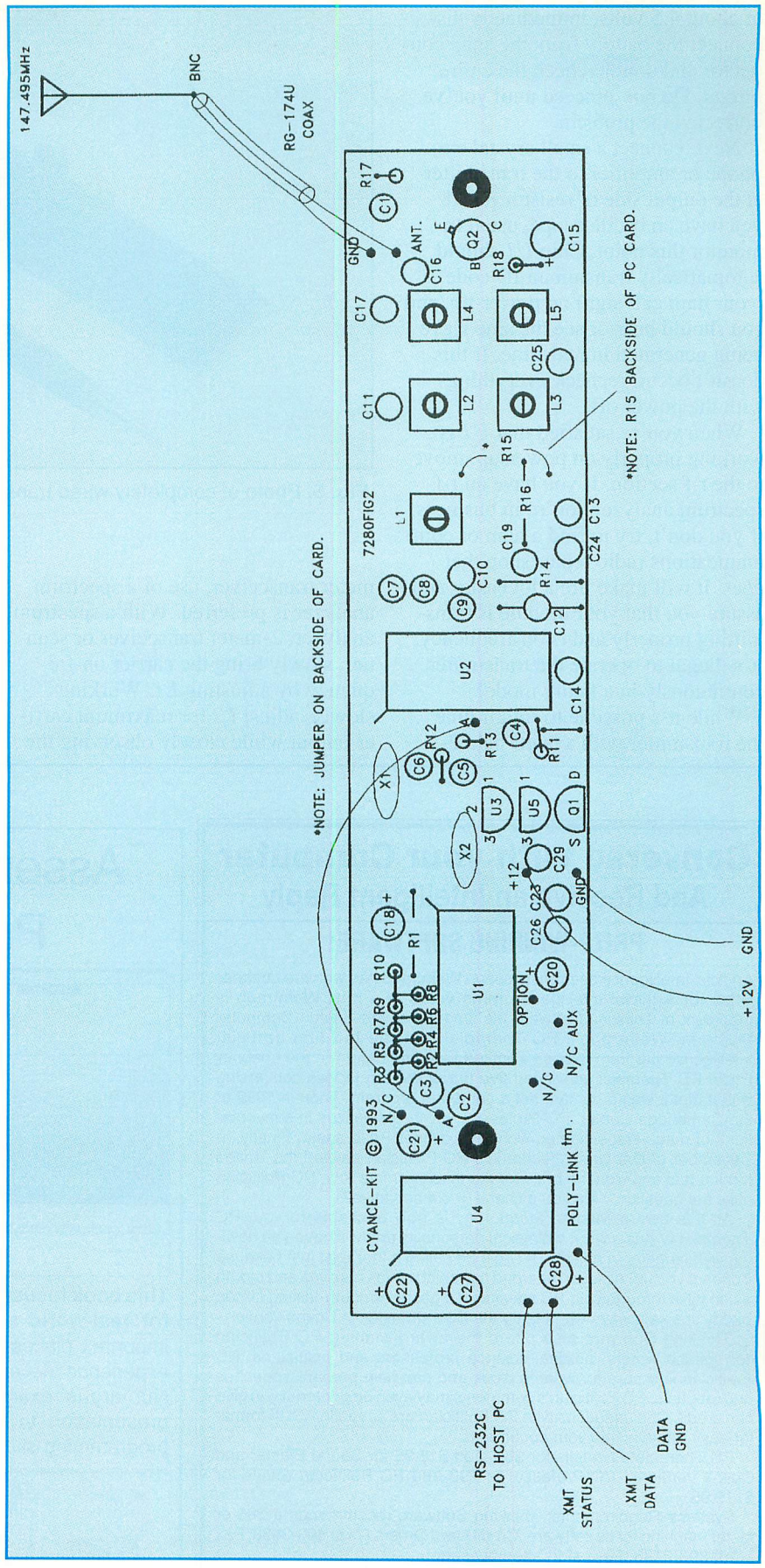


Fig. 4. Wiring guide for transmitter pc board.

of about 4.5 volts, immediately disconnect the battery from the snap connector and double-check the entire circuit. Do *not* proceed until you've corrected the problem.

Next, connect a small crystal earphone or amplifier to the transmitter at the output side of resistor *R3*. If you have an oscilloscope, use it to monitor this point. Chip *U1* should automatically transmit an ID code (your ham call sign) on power-up, and you should hear or see the sine wave being generated in real-time. If this doesn't occur, recheck everything with the power off.

When you're satisfied that *U1* is working properly on power-up, move to the r-f section. If you have an r-f spectrum analyzer you're in business. If you don't, try to find a ham or communications radio repair shop that does. It will make life a lot easier and assure you that your module is transmitting properly and is on-frequency. It's illegal to operate the transmitter continuously in a faulty mode!

While it's possible to rough-tune the transmitter with a hand-held 2-meter transceiver, use of a spectrum analyzer is preferred. With a spectrum analyzer, 2-meter transceiver or scanner, slowly bring the carrier on-frequency by adjusting *L1*. Working slowly, adjust *L2* for maximum carrier output while closely observing the harmonics near the output frequency. Do the same with *L3*, *L4* and *L5*. You want maximum power output at exactly 147.495 MHz if you're using the standard crystal. Repeat the tuning of the coils until you observe no change in maximum response.

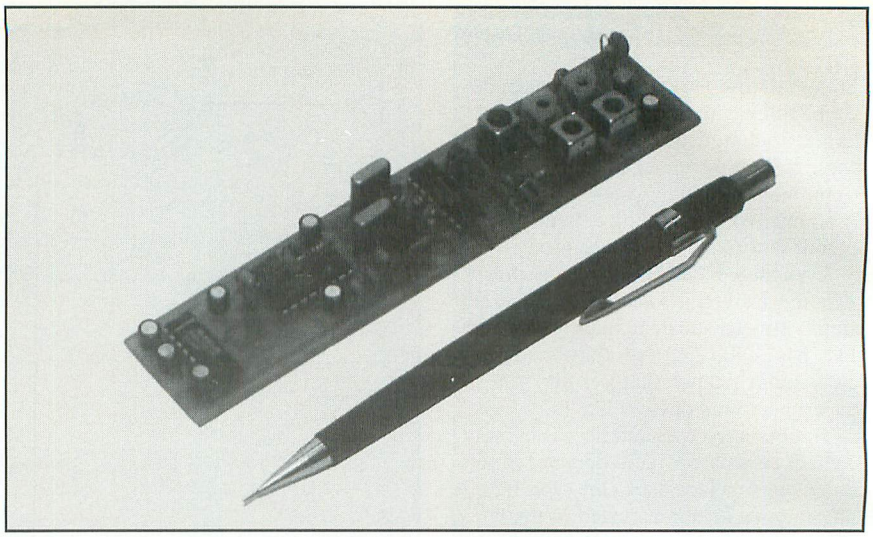


Fig. 5. Photo of completely wired transmitter circuit-board assembly.

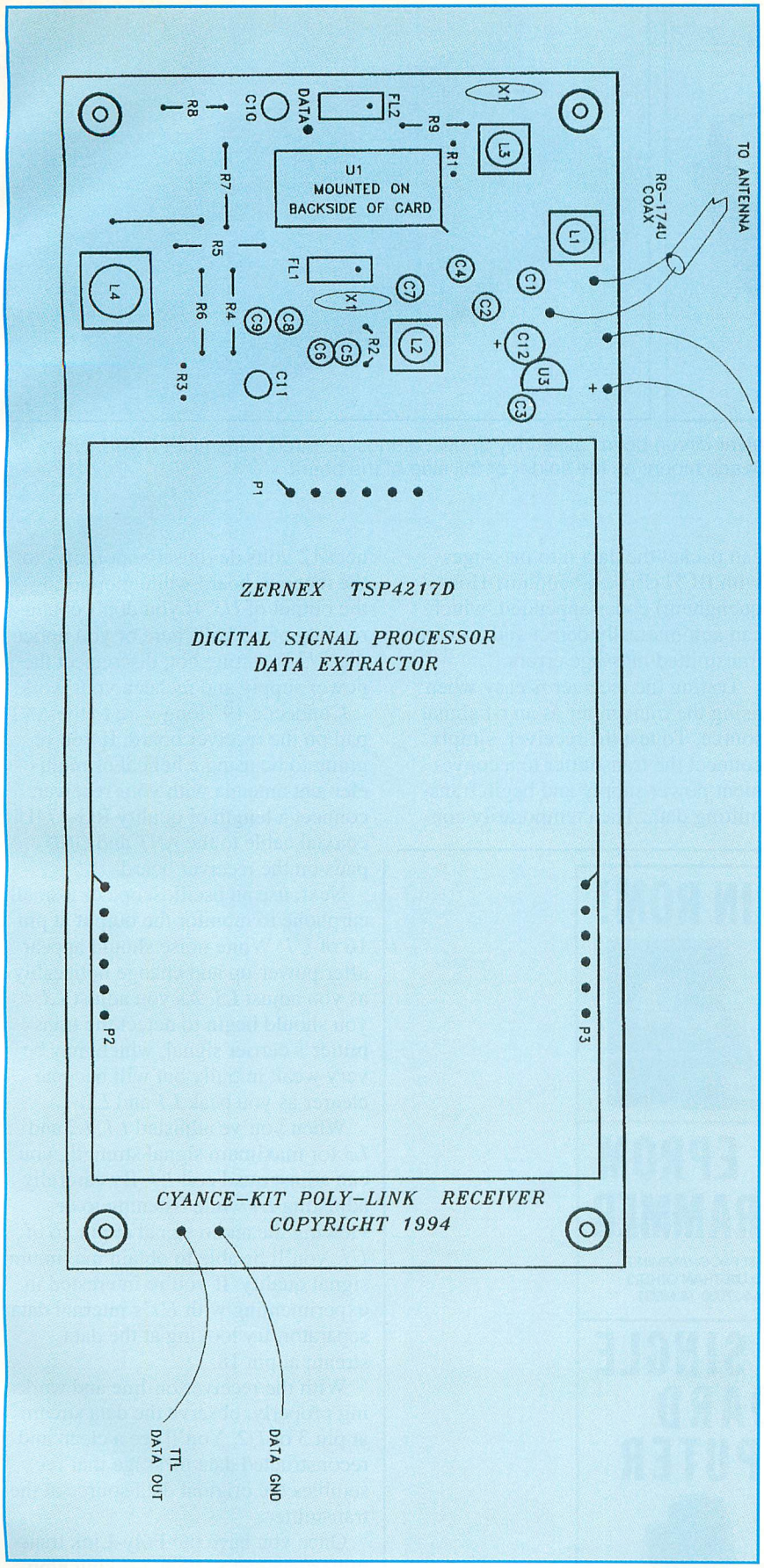


Fig. 6. Wiring guide for receiver pc board.

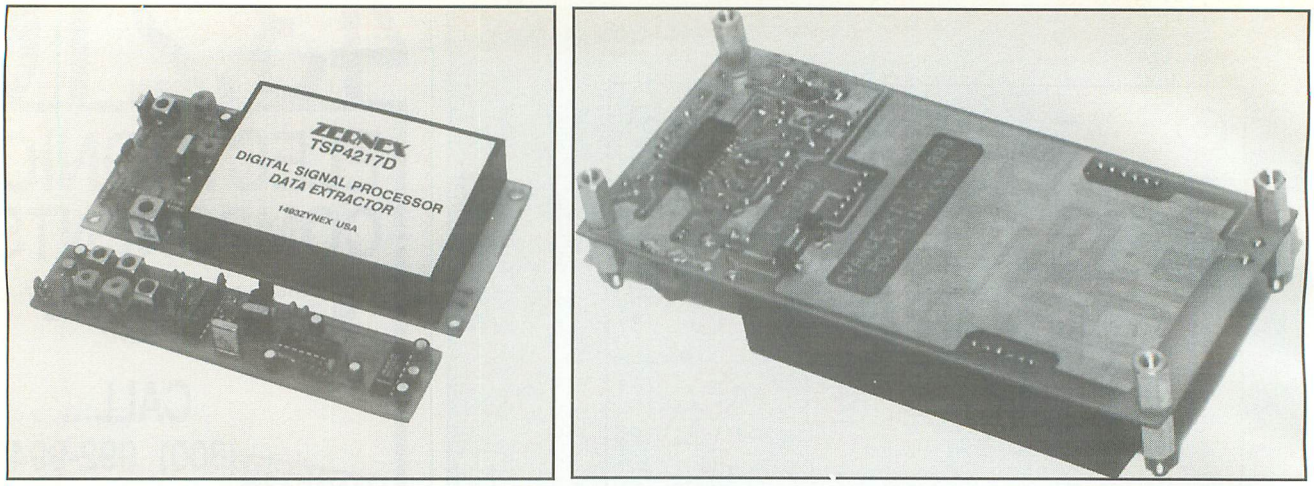


Fig. 7. Photo of (A) completely wired receiver circuit-board assembly shown alongside wired transmitter board. Notice in (B) that surface-mount *U1* and the ferrite beads mount on the solder or foil side of the board.

As a final test, write a short BASIC routine that outputs ASCII data to the serial port of your host PC or microcontroller unit. (Don't forget to configure the COM port.) The standard pre-programmed *U1* microcontroller will simply forward the marks and spaces created by the ASCII data stream. Specialized message formats available from the source mentioned in the Note at the end of the Parts List can packet the data into messages with BCH (Bose-Chaudhuri-Hocquenghem) codes appended, which can automatically detect and correct transmitted message errors.

Testing the receiver is easy when using the transmitter as an r-f signal source. To test the receiver, simply connect the transmitter to a convenient power supply and begin transmitting data. Then temporarily connect 12 volts dc (observe polarity) to the receiver board while monitoring the output of *U3*. If you don't obtain a reading of +5 volts here or you notice that *U3* is getting hot, disconnect the power supply and recheck your work.

Connect a 19"-long wire to the ANT pad on the receiver board. If you're going to be using a helical or multi-element antenna with your receiver, connect a length of quality RG-174U coaxial cable to the ANT and GND pads on the receiver board.

Next, use an oscilloscope or a small earphone to monitor the output at pin 16 of *U1*. White noise should appear after power-up and change noticeably as you adjust *L3*. As you adjust *L3*, you should begin to detect the transmitter's carrier signal, which may be very weak initially but will become clearer as you peak *L1* and *L2*.

When you've adjusted *L1*, *L2* and *L3* for maximum signal strength, you can adjust quad coil *L4*. By carefully adjusting *L4* while listening to or viewing the audio signal at pin 16 of *U1*, you'll be able to obtain maximum signal quality. If you're interested in experimenting with *U1*'s internal data separator, try looking at the data stream at pin 18.

With the receiver on-line and working properly, observe the data stream at pin 3 of *U2*. You'll see a clean and reconstructed data message that resembles the original data source at the transmitter.

Once you have the Poly-Link transmitter/receiver system working properly and tuned for maximum re-

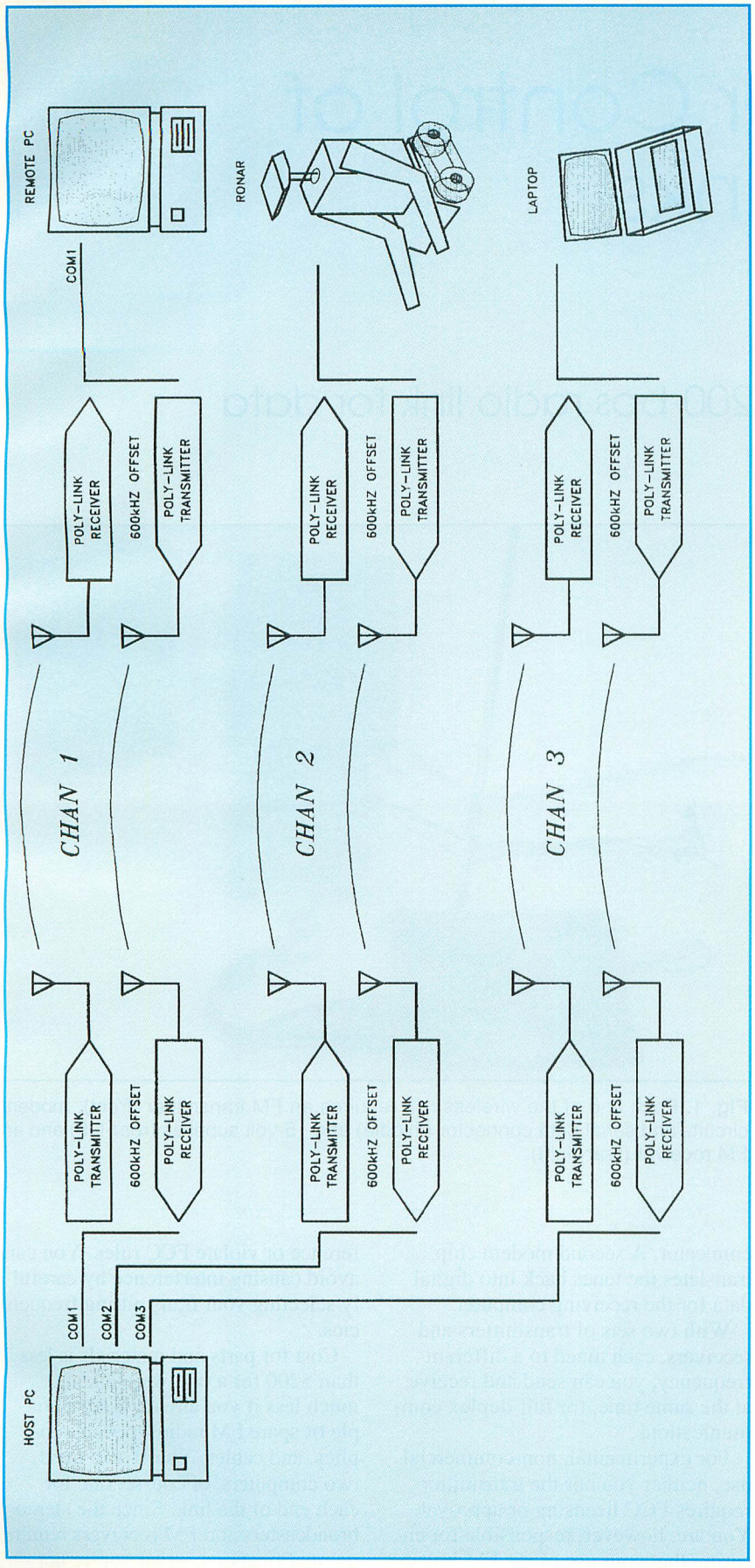
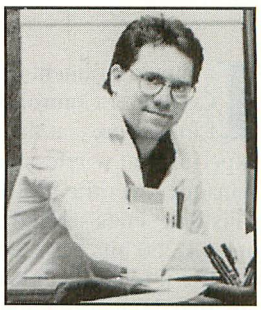


Fig. 8. Some system *configurations* possible with the Poly-Link system.

sponse, you can begin experimenting with it. Applications for this compact communications system are many. Just three possibilities are illustrated in Fig. 8.

Final Remarks

Experiment with the Poly-Link communication system, and think up as many simplex (one-way) and duplex (two-way) configurations as you can. You might also want to begin gathering some basic information on channel coding theory and brush up on the matrix algebra required to master the polynomial error-correction codes that are often employed. ■



Nick Goss

By Jan Axelson

Computer Control of Wireless Links

Part 5

An experimental 1,200-bps radio link for data communication

In this installment of our series on Computer Control of Wireless Links, I present the design of an experimental wireless data link that transmits over the FM broadcast band. This link sends serial data at speeds of up to 1,200 bits per second (bps). You can use it to communicate between any two devices that have serial ports, including personal computers, microcontrollers and single-board computers, in any combination. You could even set up a simple network, with a master computer that sends to and receives from two or more devices, and you can transmit from one room, floor, or building to the next. You can send any data that can be written to your computer's RS232 serial port.

With good antennas and a sensitive receiver, the transmitter's range is up to 1/4 mile. Over short distances, the link works well with simple whip antennas and low-cost receivers. Setting up the link the first time requires some aligning, but once it's up and running, it operates reliably.

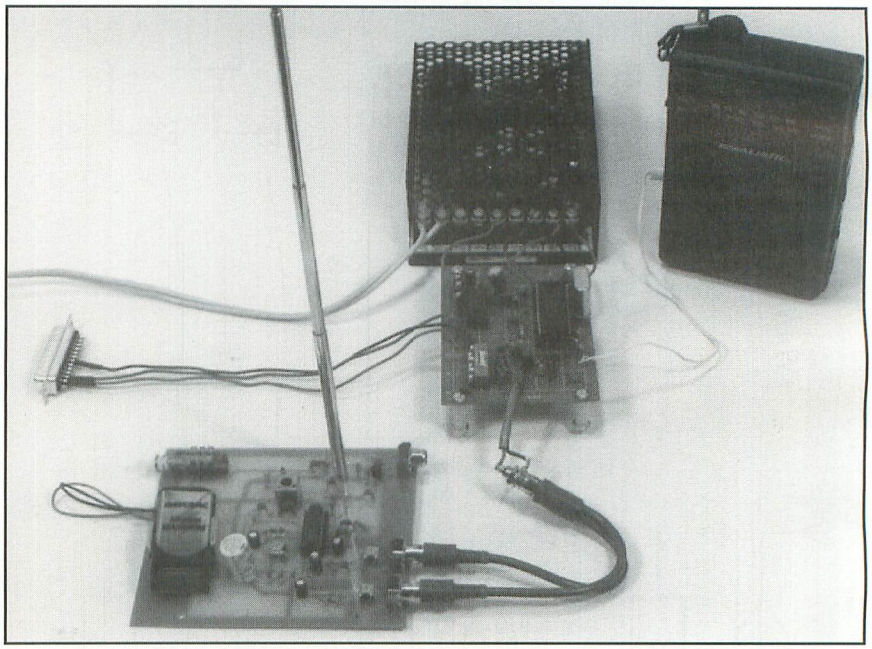


Fig. 1. Each end of the wireless link requires an FM transmitter (front), modem circuits and serial data connector (middle) and ±5-volt supplies (rear-left) and an FM receiver (rear-right).

Shown in Fig. 1 is one end of the link, with the other end containing the same elements. Several building blocks simplify construction and setup.

On the transmit side, a modem chip receives the computer's digital data and converts it into audio tones. The transmitter is a low-cost stereo broadcaster, built from a kit, that frequency-modulates the tones onto a carrier frequency in the FM broadcast band. On the receive side, an ordinary FM radio detects the carrier, extracts the audio tones and makes them available at an earphone jack or other output connector. A second modem chip translates the tones back into digital data for the receiving computer.

With two sets of transmitters and receivers, each tuned to a different frequency, you can send and receive at the same time, for full-duplex communications.

For experimental, non-commercial use, neither you nor the transmitter requires FCC licensing or approval. You are, however, responsible for ensuring that your use of the FM broadcast band doesn't cause harmful interference or violate FCC rules. You can avoid causing interference by carefully selecting your transmitting frequencies.

Cost for parts and materials is less than $200 for a two-way link and much less if you already have a couple of spare FM radios, power supplies, and cables. You'll also need two computers, of course, one for each end of the link. Since the stereo broadcasters and FM receivers require no modifications, when you're not using the data link, you can use these

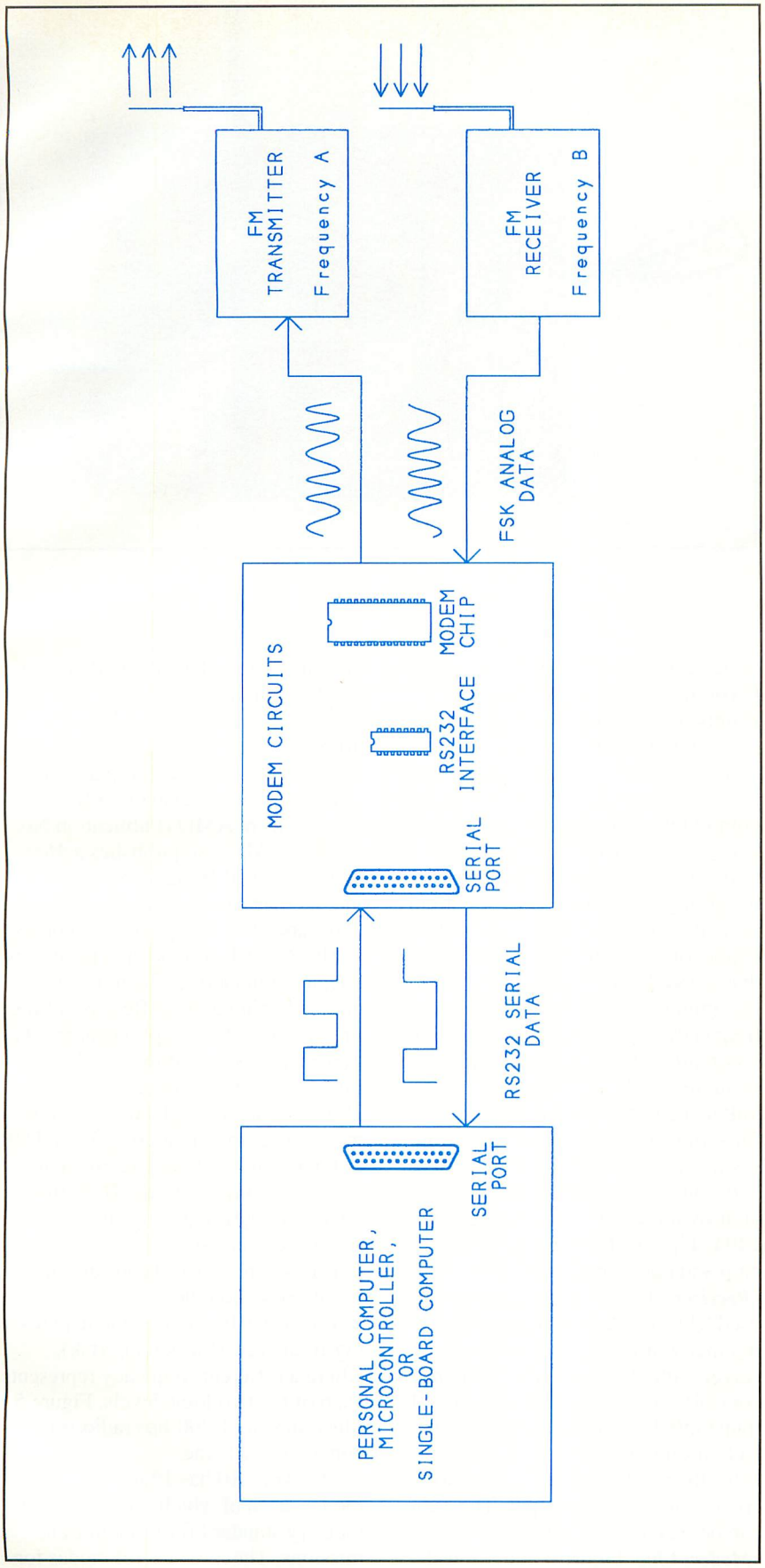


Fig. 2. Block diagram of one end of the wireless link. The opposite end is the same, with complementary transmitting and receiving frequencies.

components for their conventional purposes.

Theory of Operation

Shown in Fig. 2 is a block diagram of one end of the link. The other end contains identical components but is tuned to complementary transmitting and receiving frequencies.

The transmitting computer sends the data to its serial port. The PC can be any computer that has an asynchronous RS-232 serial port that transmits at 300 or 1,200 (bps). A MAX232 chip translates the RS-232 potentials into 5-volt logic levels. An AMD 7910 modem chip encodes the voltages as sine waves, with different frequencies that represent 1s and 0s.

The FM transmitter sends the sine waves over the air to a receiver tuned to the transmitter's carrier frequency. The receiving modem converts the tones back into digital data, and a second MAX232 chip converts the data to RS-232 voltages for the receiving computer.

You may be wondering why it's necessary to convert the digital data into audio tones. One reason is that the stereo transmitter, and the FM broadcast band it uses, are intended for transmitting audio frequencies, which consist of sine waves, or combinations of sine waves, at 15,000 Hz or less. The modem's output easily falls within this band.

In contrast, a 1,200-bps digital transmission may sound like it's a low-frequency signal, but its square pulses are actually made up of sine waves of many different frequencies, some much greater in frequency than the 1,200 bps transmission rate.

Another reason to use modem chips is that their filters do a very good job of detecting the transmitted tones and rejecting noise and interference that the receiver may pick up. The result is a high-quality link, without additional filtering.

• ***Transmitters.*** For the FM broadcasters, I used Ramsey Electronics' FM Stereo Transmitter kits. Figure 3 shows one of the transmitters I built. The circuits are designed as a wireless extender for compact-disk (CD) players or other audio equipment. For example, you can connect the line-level outputs of a CD player to the transmitter and listen to the CD in another

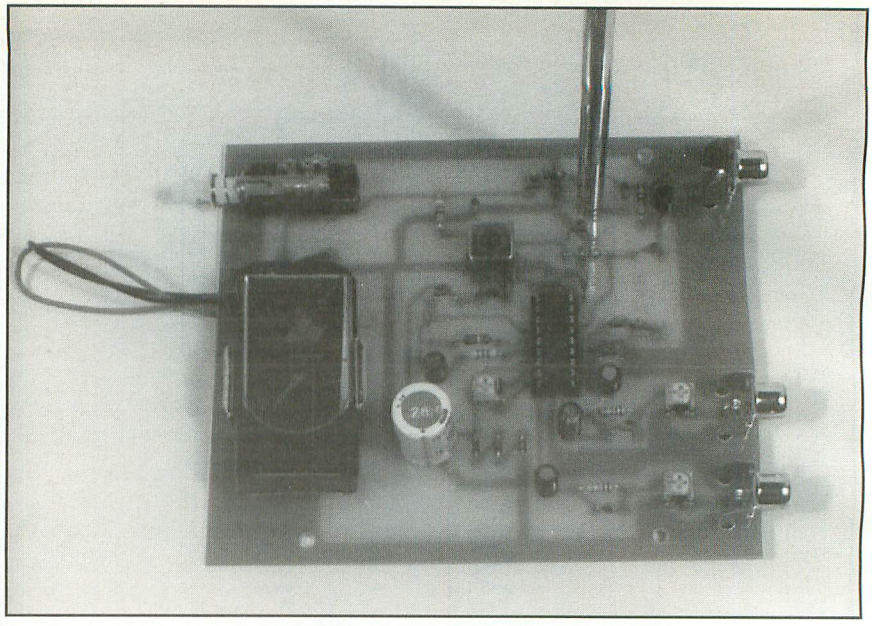


Fig. 3. *The FM Stereo Transmitter, built from Ramsey Electronics' kit.*

room or outdoors or even broadcast to several locations at once, without stringing wires or having to carry the CD player with you.

The transmitter can have other uses as well. Because it's designed as a stereo extender, the quality of the received audio signal is excellent. It doesn't exhibit the clipping and other distortion introduced by some inexpensive wireless microphones. You don't need stereo to transmit simple tones, but stereo transmitting does no harm. You can use a low-cost monaural radio to receive a signal that contains the combined left- and right-channel signals.

The transmitter uses a special BA-1404 stereo transmitter chip, that contains a stereo modulator, FM modulator and r-f amplifier. With the kit, you also get a 38-kHz crystal for the stereo modulator, input conditioning for the left and right channels, a balance control, tuning circuits for setting the transmitting frequency, an r-f amplifier and diodes that provide a constant 2.1 volts to power the BA1404. The $29.95 kit includes a printed-circuit board, manual and all required parts, except a 9-volt battery, cables and antenna.

Phono jacks connect to the left- and right-channel audio inputs. A third phono jack lets you attach an antenna. For $12.95 extra, you can buy a plastic enclosure and whip antenna. The antenna screws into a hole on the pc board, rather than using the provided phono jack. Since the enclosure has no hole for the board-mounted antenna, you have to drill one for it or use a different antenna.

For transmitting at 88 to 108 MHz, a 1/4-wave antenna would range from 27" to 34" in length. Ramsey recommends using a short length of coaxial cable to connect a dipole antenna to the antenna jack.

Building the kit involves the usual soldering of components to a pc board. The manual details the straightforward steps. When you build the kit, you have to decide whether to transmit in the low, middle or upper range of the FM band and then choose one of three included capacitors to match. If you later change your mind, you simply unsolder the capacitor and replace it with a different one.

Ramsey's kit is one of many low-power FM transmitters on the market, both in kit form and factory wired. If you're considering using another transmitter, one thing to look for is the ability to stay on frequency. In my first attempt at this project, I used a couple of $10 wireless microphones that worked perfectly, but only for a few minutes at a time. After that, the frequency began to drift. So I had to constantly retune, which was inconvenient, to say the least. Ramsey's transmitter seems to stay on-frequency. This kit is available direct from Ramsey and also from JDR Microdevices.

If you want to design and make your own transmitter using the BA-1404 chip, DC Electronics sells the chip and data sheet for $2.

• ***Receivers.*** For the FM receivers, I used $15 monaural portable radios—in other words, nothing fancy. A receiver with afc (automatic frequency control) should help it to lock onto the transmitted frequency. An earphone jack or other output connector eliminates the need to open the radio to connect to an audio output. The radio can be battery- or ac-powered.

• ***Modem Chip.*** Figure 4 and Table 1 show the pinout and pin functions of the Am7910 modem chip. One supplier of the chip is Jameco, with a price of $14.95. For $2 more, you also get a copy of Advanced Micro Devices' 40-page data sheet, which has many more details about the chip and how to use it. You can also order the data directly from AMD (Publication No. 04262). AMD also publishes a *Modem Technical Manual* (No. 09560C) that includes an introduction to modems and more interfacing examples.

The Am7910 is designed for use in telephone modems, which transmit data over phone lines. Because of the limitations of the telephone network, transmissions over ordinary phone lines are limited to frequencies from 300 to 3,400 Hz, with signaling information transmitted at up to 4,000 Hz).

To transmit digital data, modems convert the binary 1s and 0s to frequencies, represented by sine waves. If you've ever listened to a modem transmission, you've heard the sine waves as audio tones.

The Am7910 encodes the data using frequency-shift keying (fsk), where a different frequency represents each of the two logic levels. Figure 5 illustrates the 1,200-bps radio-link's conversion scheme.

The Am7910 has 19 transmitting modes, each of which conforms to an industry standard for modem transmissions. The most useful modes for the wireless circuits described here are ones that transmit at 300 and

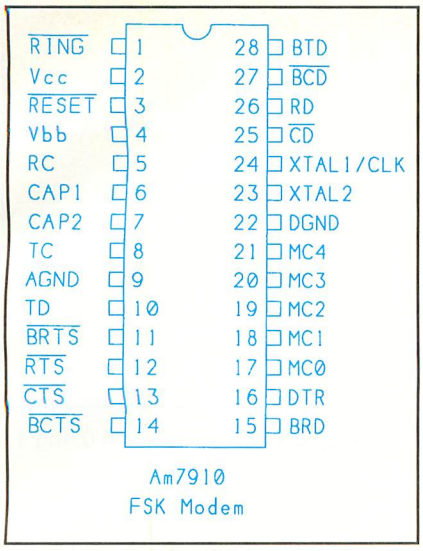


Fig. 4. Pinout of AMD's Am7910 FSK modem chip.

1,200 bps. Table 2 lists the settings for four of the modes.

At 300 bps, the modem uses four encoding frequencies. One end of the link is designated the originating modem, the other the answering modem. The originating modem transmits a 1 as a sine wave of 1,270 Hz, and a 0 as 1,070 Hz. The answering modem uses a different frequency pair, with a 1 as 2,225 Hz and a 0 as 2,025 Hz. The receiving circuits at each end expect to see the opposite set of frequencies.

These frequencies conform to the Bell 103 standard for modem transmissions. Because each direction of transmission uses a different part of the transmission band, the modem can send and receive at simultaneously over the same pair of wires.

At 1,200 bps, the modem uses just two frequencies. In the Bell 202 standard, a 1 is represented by 1,200 Hz, a 0 by 2,200 Hz. The Am7910 also supports the CCITT V.23 standard, which uses slightly different frequencies for 1,200-bps transmitting.

Over ordinary phone lines, the Am7910's 1,200-bps transmissions are half-duplex. In other words, because both directions of transmission use the same frequency pair, and because telephones use the same two wires for transmitting and receiving, you can transmit in only one direction at a time. However, the Am7910 has a special loop-back mode that permits full-duplex transmissions for circuits like the wireless link, whose transmit and receive circuits are separate.

You might wonder why you can't use the four Bell 103 frequencies at 1,200 bps. The reason is that these are suitable for only slower transmissions. At higher speeds, the circuits need a wider bandwidth to reliably detect the frequencies, and at 1,200 bps, there's room for just two frequencies. For full-duplex communications at 1,200 bps, most computer modems use the Bell 212A standard, which uses phase shifting in addition to frequency shifting. The Am7910 doesn't support this mode.

About the Circuits

Figure 6 is a schematic diagram of the modem circuit. It also shows how the computer and radio interfaces to it. MAX232 *U1* is an RS-232 receiver/driver chip. Pins 13 and 14 connect to the data output (TX) and input (RX) of a computer's serial port. Pin connections are shown for a 25-pin female D-shell connector that plugs into a male connector on the computer. The D connector also requires grounding at pin 7. If you have a different serial connector, you need to know its pinout and wire the connections to match.

Inversion of the transmitted and received data and translation between 5-volt logic and RS-232 voltages are accomplished with *U1*. Pin 10 of Am7910 modem *U2* receives the digital data to transmit, and pin 8 outputs the data as sine waves. This output connects directly to the left and right-channel inputs on the stereo transmitter. The transmitter's level-adjust potentiometers control the amplitude of the transmitted sine waves.

In the other direction, pin 5 receives the sine waves from the earphone jack on the FM receiver and converts them to digital voltages at pin 26.

The Am7910's data sheet gives no minimum required signal level for pin 5, just a maximum of ±1.6 volts. In practice, I found that the chip wasn't particular at all about input voltages and responded to inputs as low as 30 mV peak-to-peak.

Capacitor *C9* removes any dc offset on the received signal. Resistor *R3* provides a path for the dc bias current, as recommended by the data sheet. Potentiometer *R4* adjusts the ampli-

Table 1. Pin Functions for AM7910 Modem

Pin	Name	I/O*	Function
1	–RING	I	Begin Autoanswer
2	Vcc	I	+5 Volts
3	–RESET	I	Reset to Initial Conditions
4	Vbb	I	–5 Volts
5	RC	I	Main Channel Received Carrier
6	CAP1	I	R/C for A/D Converter
7	CAP2	I	R/C for A/D Converter
8	TC	O	Main Channel Transmitted Carrier
9	AGND	I	Analog Ground
10	TD	O	Main Channel Transmitted Data
11	–BRTS	I	Back Channel Request to Send
12	–RTS	I	Main Channel Request to Send
13	–CTS	O	Main Channel Clear to Send
14	–BCTS	O	Back Channel Clear to Send
15	BRD	I	Back Channel Received Data
16	DTR	I	Data Terminal Ready
17	MC0	I	Mode Control 0
18	MC1	I	Mode Control 1
19	MC2	I	Mode Control 2
20	MC3	I	Mode Control 3
21	MC4	I	Mode Control 4
22	DGND	I	Digital Ground
23	XTAL2	I	Master Timing Crystal
24	XTAL1/CLK	I	Master Timing Crystal/Clock
25	–CD	O	Carrier Detect
26	RD	I	Main Channel Received Data
27	–BCD	O	Back Channel Carrier Detect
28	BTD	O	Back Channel Transmitted Data

*I/O = Input/Output.

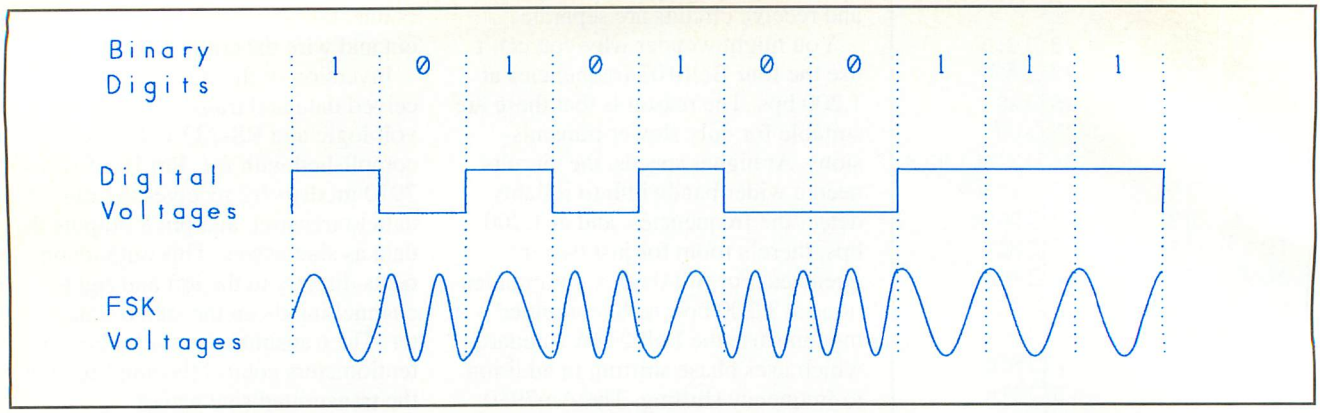


Fig. 5. Frequency-shift keying (FSK) encodes binary data as frequencies, with different frequencies representing 0 and 1.

tude of the received signal, or you can omit *R4*, wire the earphone directly to *C9* and use the radio's volume control to adjust the level.

Switches *S1* through *S5* select the transmitting mode. At pins 6 and 7, *C10* and *R5* are recommended values for the modem's analog-to-digital (A/D) converter.

Pins 23 and 24 connect to a 2.4570-MHz crystal, which clocks the modem's internal circuits. Jameco carries the crystals.

The modem chip has several inputs and outputs that are intended for use as control signals and for transmitting and receiving over a low-frequency back channel. Since the wireless link uses a simple three-wire RS-232 connection, it doesn't use most of these features, although you can connect and use them if you wish.

The carrier-detect output at pin 25 goes low when the receiver detects an in-band signal. An optional LED gives a visual indicator of this.

Resistor *R11* and capacitor *C11* ensure a valid reset on power-up. In addition, after reset or a mode change, DTR input pin 16 must be held low briefly to reset the chip's internal state machine to its initial conditions. Resistor *R1* and capacitor *C8* perform this function on power-up.

The chip has two ground connections, for the analog and digital circuits at pins 9 and 22, respectively. These are separate to help keep digital noise out of the analog circuits. For best results, connect the two grounds at only a single location and as close as possible to the power supply's ground. In other words, tie the grounds at pins 5 and 8 to pin 9. Then wire pin 9 directly to the ground connection on the power supply. Fifure 6 uses different symbols to distinguish between the grounds.

The modem chip requires two power supplies: +5 and –5 volts. In addition, you need to power the FM transmitter and receiver. For the transmit- ter, you can use the 5-volt supply in place of the 9-volt battery, if you wish. The transmitter draws about 35 mA.

The Am7910 requires a maximum of 140 mA at +5 volts, but just 15 mA at –5 volts. Chips like Maxim's MAX660 provide an inexpensive way to generate –5 volts from a +5-bolt supply.

Construction

I wired the modem circuits using Wire Wrap materials, with a DIP switch to select transmit modes (see Fig. 7). I used shielded Y-adapter cable with mono phono plugs at each end to feed the modem output to both channels of the transmitter. Radio Shack is one source for the cables.

For the receiver, I used a two-wire cable with a monaural phone plug to match the earphone jack. With a stereo receiver, you should be able to use either channel for the modem input.

You can eliminate the RS-232 interface if you're connecting the circuits to a serial port on a single-board computer and if the connecting wires are short. Without the MAX232, connect pins 10 and 26 of *Ux* directly to the 5-volt serial input and output of the single-board computer.

When you're ready to try out your circuits, there are a few preliminary checks you can perform to see if the circuits are operating properly. Use the procedures suggested in the manual to test the transmitters. On a receiver, find an empty spot on the FM dial. (You should hear noise but no programming.) Then turn on your transmitter and adjust the tuning coil until the receiver quiets, which indicates that it's receiving your transmitted signal.

For two-way communication, you'll need to find two empty spots on the dial. Ramsey's manual contains advice about how to find a transmitting frequency. In short, you have absolutely no right to interfere with licensed broadcast stations. To find an unused spot, monitor the broadcast band with a good-quality receiver.

Commercial FM stations are staggered at 200-kHz intervals on the dial (there may be stations at 88.0 MHz, 88.2 MHz, 88.4 MHz, and so on up the dial. In reality, stations within an area are usually at least 400 kHz apart. Don't try to broadcast at frequencies beyond 108 MHz because this area is reserved for air-traffic control.

In FM broadcasting, the amount of frequency variation depends on the amplitude of the audio signal being transmitted, and the frequency of variation indicates the frequency of the transmitted audio signal. The 200-kHz bandwidth allows for variations of up to 75 kHz in each direction, with 25-kHz guard bands.

One advantage of using FM, instead of the AM band, is that FM receivers tend to automatically select the strongest signal and reject weaker interfering signals. In fact, in the latest revision of the Part 15 rules, the

Table 2. Selected Modes of AM7910

Mode	Baud Rate (bps)	Mark (1) (Hz)	Space (0) (Hz)	MC0	MC1	MC2	MC3	MC4
Bell 103 Originate	300	1,270	1,070	0	0	0	0	0
Bell 103 Answer	300	2,225	2,025	1	0	0	0	0
Bell 202 Main Loopback	1,200	1,200	2,200	0	1	0	0	1
CCITT V23 M2 Loopback	1,200	1,300	2,100	0	1	1	01	

FCC gave this characteristic as one reason why it was permitting unlicensed transmissions at 250 µV/meter at 3 meters, rather than the 150 µV/meter limit requested by the National Association of Broadcasters.

Testing the Circuits

When you have a receiver tuned to each transmitter, you're ready to test the modem circuits. This will be easier to do if you can set up both ends near each other to begin with. I used adjoining rooms and still got plenty of exercise running back and forth to check and adjust.

To begin, transmit at 300 bps. At pins 17 through 21 of *U2*, set the switches to configure one modem as the originator and the other as the answering modem. It doesn't matter which is which, as long as you have one of each.

Connect each modem circuit to a computer's serial port and to a transmitter. Leave the receivers unconnected for now. Set the transmitter's balance adjust to midrange and turn the level controls fully counterclockwise to turn them off then back up 1/10 turn or so. Set *R4* to the middle of its range.

Turn on one of the modem circuits, the computer it connects to and its transmitter. At the other end, turn on the receiver. You should hear the transmitted tone. If you hear noise, the transmitter isn't on or isn't working, or the receiver isn't tuned properly.

If you hear silence with the transmitter on and noise with the transmitter off, the transmitter is working but the tone isn't transmitting. Check your cabling between the modem and transmitter. Turn the level controls clockwise to increase the amplitude of the transmitted tones. If you have an oscilloscope, you can trace the output from pin 8 on the modem to the audio inputs on the transmitter. Be sure that the mode-select inputs are correct. If you change mode, power down and back up to reset the modem.

If the tone sounds distorted, decrease the input levels with the transmitter's level-adjust potentiometers. Tune the receiver for the best-quality reception.

When you hear a clear tone, it's a good idea to tune through the dial to verify that your transmissions aren't interfering with licensed broadcasts. If all appears to be okay, plug the receiver into the modem circuits at the receiving end and turn on the modem circuits and the computer they connect to. You should now be able to communicate in one direction.

A personal computer at each end makes it easy to run some basic tests. If you have a different setup, you'll have to devise your own testing procedures, based on the hardware you have.

On a personal computer, run your communication or terminal-emulation software. Set it up for 300 bps, with no RTS/CTS or other handshaking. To be able to see what you type, select "echo on," or half-duplex communication. In this case, half-duplex means only that the computer provides its own echo, which is necessary because the modem chip doesn't echo back what you type.

You can now type something at the transmitting computer and see if it shows up on the receiving computer's display monitor. If you see nothing, turn up the receive level at *R4* and try again. If you listen to the receiver, you should hear the frequencies change as you type. If you hear no changes, be sure that your computer's RS-232 output is wired correctly, through the MAX232, to pin 10 of the modem.

At one point, I had a crystal at *U2* that was oscillating at 2.8 MHz, which is 15% beyond its rated frequency. The result was that the modem's RD output didn't change in response to changes at the RC input. Because the receiving modem's timebase was inaccurate, the modem interpreted the received signals as off-frequency and, thus, ignored them. In the other direction, the too-fast crystal caused the modem to transmit the wrong frequencies, and the receiving modem rightly rejected them as well. So, if you encounter symptoms like these, check your crystal.

When all looks okay, you can try sending a text file from one computer to the other. At the transmitting end, select upload, ASCII format and the desired filename. You should see the text of the file appear on-screen at the receiving end.

When you're confident that the link is working in this direction, turn off its transmitter, connect and turn on the second transmitter and repeat the tests in the other direction. Since the second modem chip uses a different set of frequencies, the tones will sound different at the second receiver.

When the transmissions in the other direction look good, you can turn on both transmitters at once. It's a good idea to physically separate the transmitting and receiving antennas at each end as much as possible, although a few feet of separation was enough in my experiments. Don't place one antenna in front of the other.

Try typing messages from each end. If the link doesn't work properly with both transmitters on, try changing one of the transmitter frequencies to eliminate interference.

One good way to test two-way transmissions is to send a file using Xmodem protocol. With Xmodem, the transmitting end sends a block of data and then waits to receive a veri-

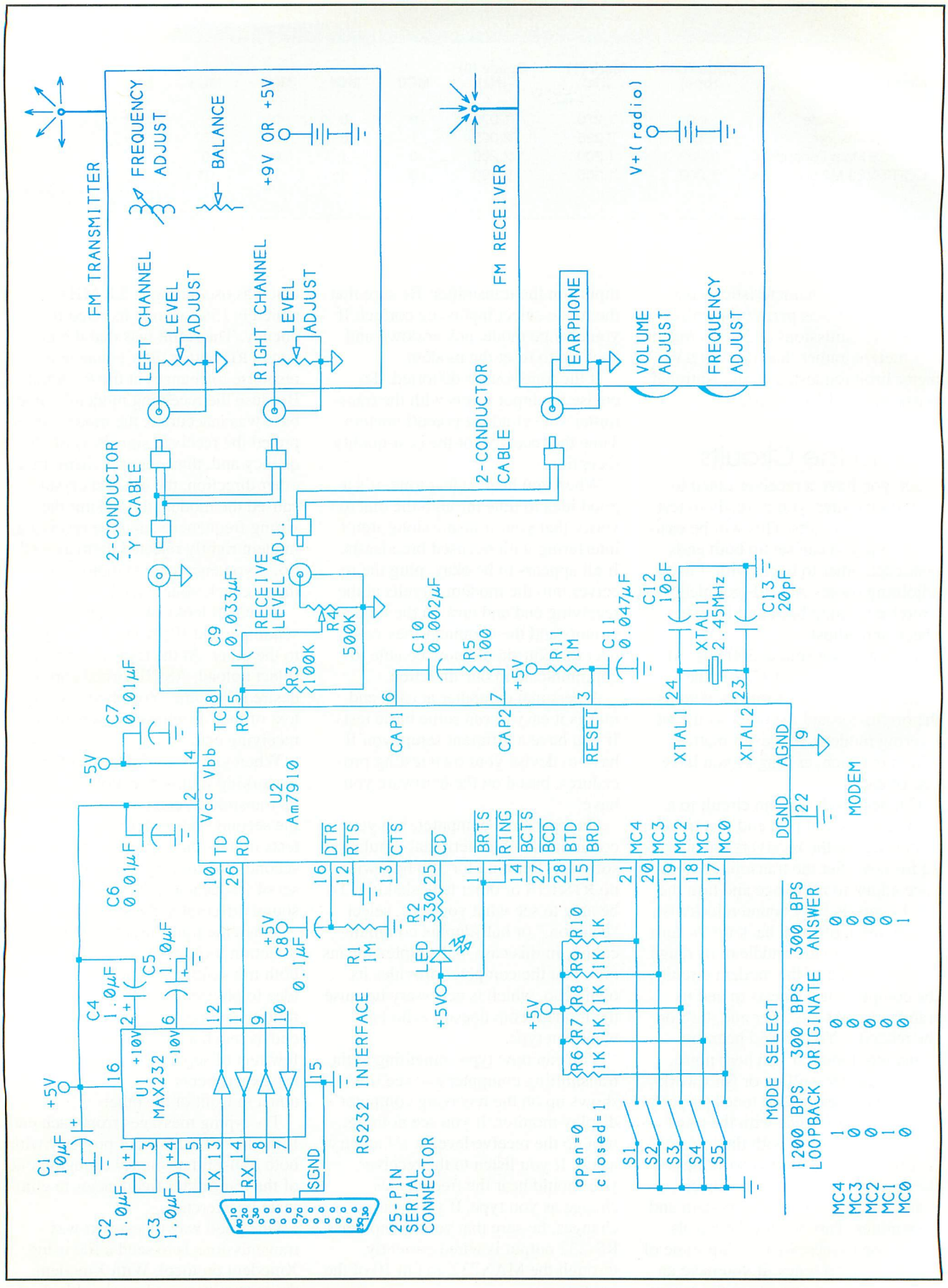


Fig. 6. Schematic diagram of one end of the wireless link.

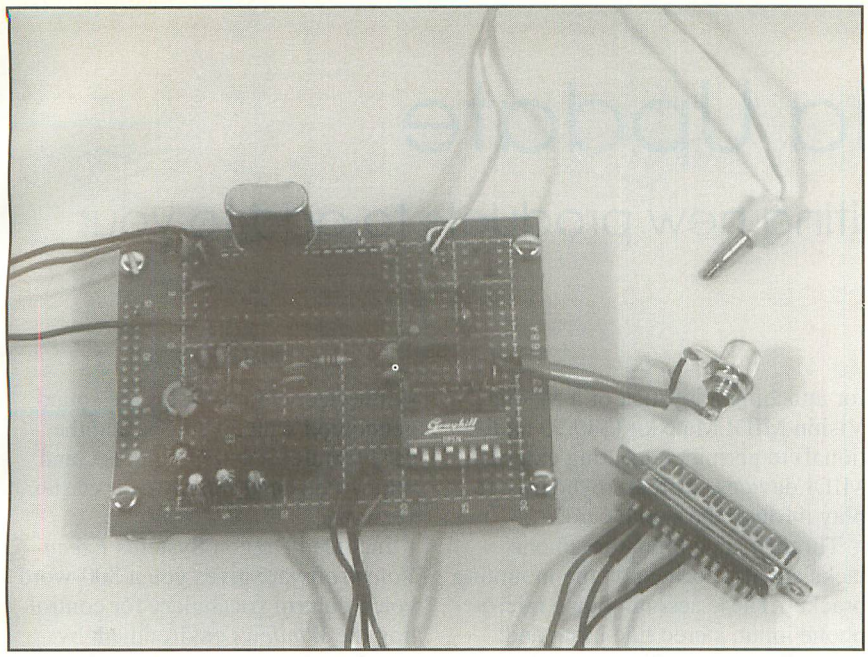


Fig. 7. Modem circuits, including an earphone plug for the FM receiver, a phono jack for the FM transmitter, and D-connector for the computer's serial data.

fying check value before sending the next. If the received value is incorrect, a transmission error occurred and the transmitting computer resends the block, several times if necessary, depending on the software, before giving up and ending the transfer attempt.

Most communication software includes Xmodem transfers as an option. You have to set up the transfer at both ends. Many communication programs display the progress of the file transfer, including the number of errors encountered. An error-free Xmodem transfer of a long file means that your link is working very well.

When you're up and running at 300 bps, you can try 1,200 bps. Turn off the modem circuits, change the mode-select inputs for 1,200 bps and power back up. Reconfigure your software for 1,200 bps. Your link should work as before, only faster.

As with any experimental transmissions, you want to use the minimum power necessary to do the job. To increase your ability to receive the transmitted signals, use a receiving antenna that's sized to match the transmitted frequency, adjust *R4* for best reception and use the most-sensitive FM receiver you can. You can lower transmitted power by decreasing the transmitter's supply voltage, using a shorter transmitting antenna and lowering the amplitude of the audio signal at the transmitter. Also, be sure to turn off the transmitters when you aren't using them. To remotely control power to a transmitter, you could wire a transistor switch or relay to the remote modem's carrier-detect output so that its transmitter turns on only when it detects an incoming signal.

You can use the link to send any type of serial data. For example, I found that it works well as a wireless link between a personal computer and an 8052-BASIC microcontroller. Because the 8052-BASIC echoes back what it receives, select echo off, or full duplex, at the personal computer for this use.

Moving on

I'm interested in hearing from anyone who puts together the wireless link, or a similar one, and what you're using it for. In other news, my book *Making Printed Circuit Boards*, is now available from TAB-McGraw Hill ($19.95 in paperback, 1-800-822-8138).

You can reach me on Compuserve at 71163,3555, on Internet at 71163.3555@compuserve.com, or by mail at Box 3374, Madison, WI 53704-0374. For a personal reply by mail, please include a self-addressed stamped envelope. ■

Jan Axelson

Sources

AMD (Advanced Micro Devices)
901 Thompson Pl.
Sunnyvale, CA 94088
1-800-222-9323
Tel.: 408-749-5703

CIRCLE NO. 150 ON FREE INFORMARTION CARD

DC Electronics
PO Box 3203
Scottsdale, AZ 85271-3203
Tel.: 1-800-423-0070

CIRCLE NO. 151 ON FREE INFORMARTION CARD

Jameco
1355 Shoreway Rd.
Belmont, CA 94002
Tel.: 1-800-831-4242 or
415-592-8097

CIRCLE NO. 152 ON FREE INFORMARTION CARD

JDR Microdevices
2233 Samaritan Dr.
San Jose, CA 95124
Tel.: 1-800-538-5000 or
408-559-1200

CIRCLE NO. 153 ON FREE INFORMARTION CARD

Ramsey Electronics
793 Canning Pkwy.
Victor, NY 14564
Tel.: 716-924-4560

CIRCLE NO. 154 ON FREE INFORMARTION CARD

By Tom Benford

Multimedia Update

A look at some exciting new products to add to your multimedia setup

Multimedia has taken PC desktop computing by storm. Nowadays, buying a new PC package often means that you'll get Microsoft *Windows* 3.1, a CD-ROM player, a sound card and multimedia software along with the usual equipment now considered to be standard on the PC platform. For those of you who are already multimedia-ready (or are planning to become so in the near future), I offer the following capsule summaries of new products you might want to consider adding to your system.

Multimedia From Media Vision

Having set the PC audio world on its ear, so to speak, with the Media Vision Pro Audio Spectrum 16 sound card a couple of years ago, Media Vision now offers a Pro Audio Studio 16 audio card that takes all of the Spectrum 16's most-desirable features and includes additional functionality to it, such as voice-recognition capabilities. The enhanced software that comes bundled with this card provides a highly-automated installation program that automatically tests and detects DMA and IRQ settings to ensure freedom from conflicts with other installed devices.

Like its predecessors, Pro Audio Studio 16 is a three-quarters-length card that requires a 16-bit slot on a PC expansion bus. Its mounting bracket features the familiar 15-pin D-shell connector that's used for attaching a joystick or a Media Vision MIDI Mate kit ($49.95 additional) to permit connecting external MIDI devices, such as keyboards, to play through the sound card.

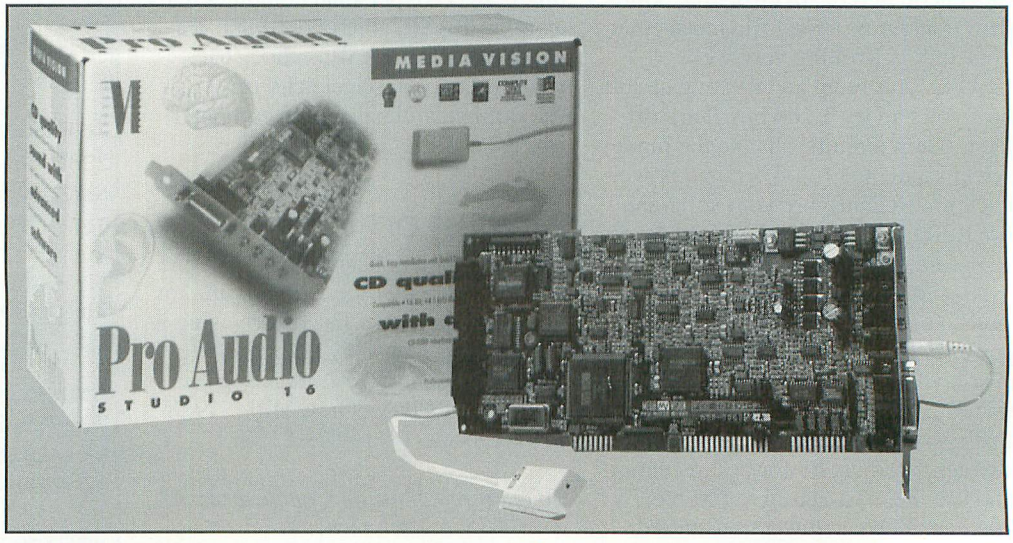
Three 1/8-inch miniature phone jacks are also located on the mounting bracket. These accommodate microphone input, stereo line input and stereo line output. Since all volume adjustments are made through software, no manual volume control is provided .

The card also has a standard 40-pin SCSI interface header for connecting a CD-ROM drive via an internal ribbon cable or by using an optional external SCSI cable ($49.95 additional). A a five-pin connector is also provided on the card for routing CD-audio through it. A good-quality, computer-mountable microphone is also included with the card.

This new card is capable of 16-bit stereo digital-audio recording and playback at rates up to 44.1 kHz for CD-quality sound. A Yamaha OPL3 synthesizer chip provides the sound generation with 20 voices, and the card features a 4-watt amplifier and improved sound fidelity over earlier versions.

Included Dragon Systems *ExecuVoice* software gives you a 300-word voice-control vocabulary for controlling the *Windows* environment by simply voicing commands. Other bundled software includes *Monologue for Windows* text-to-speech software that features 16-bit samples for better quality; MIDIsoft's *Recording Session Windows*-based MIDI sequencer; and the DigiVox *Sound Impressions* professional digital audio editing package. Also included is Media Vision's *Pocket Tools*, a set of application programs you can be use for everything from recording and editing digital audio to controlling the playback of audio CDs in a CD-ROM drive installed with the PC.

Audio mixer utilities for controlling the volume of the various sound sources are also included, as is a *Win-*



Media Vision's Pro Audio Studio 16 card offers CD-quality sound and includes advanced software.

Media Vision's Pro MovieStudio video-capture card features real-time compression.

dows-based guided tour application to showcase the card's capabilities. List price for the Pro Audio Studio 16 is $349, and a stripped-down version called the Pro Audio 16 Basic (no CD-ROM interface and less bundled software) is available for $199.

Get the (Moving) Picture

Media Vision also has a new Pro MovieStudio card. This low-cost video-capture card features real-time compression. It performs all video compression "on the fly," thus reducing the amount of CPU muscle and disk storage space required. This is accomplished via Media Vision's MotiVE video chip set, which permits capturing and storing a one-minute video file in real-time using only 4.5M of disk space. For comparison purposes, the same file would require 70M of space and take about eight minutes to compress without this proprietary two-chip set.

One of the things that immediately caught my attention about this card is its small size and highly-integrated electronics. It's only 8" long and is completely devoid of jumpers and DIP switches. All port assignments and interrupt settings are configured through the provided setup software.

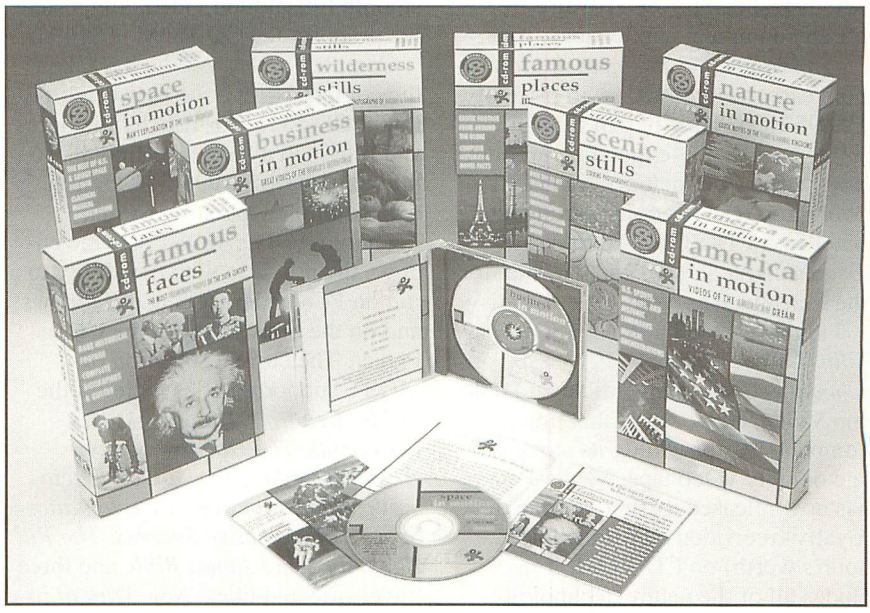
The card supports a 32,768-color palette and can capture in resolutions up to 320 X 240 while supporting NTSC, PAL and SECAM broadcast standards. Only two connectors are provided on the card's mounting bracket. One is a single composite (phono-type) jack and the other is a single S-video (miniature DIN) connector. A 16-bit slot in a 386 or later PC is required for installation.

Bundled software consists of an assortment that includes Microsoft's *Video for Windows*, Macromedia's *Authorware Star SE 2.0*, an AVI-to-*Quicktime* conversion utility and a DOS player and recorder. In use, the card lives up to MediaVision's claims. It produces excellent-quality video captures and playback with smooth, fluid motion. It's among the best I've seen to date. Suggested list for the Pro MovieStudio card is $449.

Multimedia Material on CD-ROM

From a purple mountain's majesty to amber waves of grain and just about everything in between, you'll find video clips of America in a new CD-ROM from Jasmine Multimedia Publishing. *America In Motion* is one of a series of royalty-free video and music titles being released by the company. It contains "videos of the American dream"—US sports, holidays and historic landmarks and musical orchestrations that provide the right aural background for the images. You'll find clips of the Statue of Liberty, hot-air balloons, beer bottles on parade and other substance and sound that's part of life in America.

Business in Motion, another title in



Jasmine Multimedia has a library of CD-ROMs that provide royalty-free video and music. Two titles of particular note are *America in Motion* and *Business in Motion*.

MIDI Solutions has a series of compact black-box add-ons that offer such functions as a velocity converter, all-notes-off filter, router, mapper, through, merge, footswitch control and relay.

Jasmine's series, also provides a diverse collection of clips and appropriate music with great videos of the world's work force. You'll find construction, transportation, communication and manufacturing topics, all conveniently arranged and supplied in both Intel Indeo and Microsoft AVI formats.

Each CD-ROM disc in the series provides about 30 minutes of video and about an hour of musical compositions that can be used royalty-free for any computer applications. *America in Motion* and *Business in Motion* both carry a suggested retail price of $99.95 each. They're part of Jasmine's constantly-expanding product line, which also includes some still-photography collections starting at $59.95 on CD-ROM. All titles are also available in *Quicktime* format for the Macintosh as well.

I reviewed Media-Pedia's *Video Clips* in the September 1993 issue of *ComputerCraft* in my article on Desktop Video. However, at that time, the company was providing its stock footage on only video tape. Media-Pedia has now released its first volume of royalty-free video clips (a whole hour's worth) on CD-ROM. It includes all of the nature, technology and civilization subject matter contained on its tape versions, plus some extra bonus material.

One nice thing about getting these clips on CD-ROM is that they're already in AVI format and ready for use in *Windows*. So you don't have to do your own capture from tape. They were captured and compressed using Intel's Indeo technology, and they're digitized in 24-bit color. It should be noted that playback on eight-bit graphics card may result in patchy or wavy images, and an MPC-compliant CD-ROM drive is needed to obtain smooth full-motion video. Suggested list price for the CD-ROM is $149 .

Compton's New Media has taken the compatibility issue between different CD-ROM formats by the horns and provided a "one-size-fits-all" solution by way of MOST—Compton's own Multiple Operating System Technology. The MOST scheme endows the products with the ability to run on PCs under DOS and *Windows* and on the Sony MultiMedia CD-Player. The current selection of MOST-supported titles includes the *Public Relations Handbook, U.S. Presidents, The Doctors Book of Home Remedies, Executive's Factomatic, Sales Manager's Factomatic, Secrets of Executive Success, The Pill Book,* the *King James Bible* and three travel-oriented titles: *New York at its Best, Washington D.C. at its Best* and *Hong Kong at its Best.*

Compton's will be adding additional business and reference titles to this line continually. So if you don't see something you need listed here, it will probably be available by the time you read this or shortly thereafter. All MOST-based titles have a suggested retail price ranging from $24.95 to $129.95 each.

Quanta Press has two CD-ROMs on

the subject of fractals. *Chaos: Fractals & Magic* ((($69.95) runs under DOS and *Windows* and is an assortment of material on the subject, including an extensive annotated bibliography on chaos, a chaos magic section, poetry and prose and an expanded glossary. It also contains more than 300 computer-generated and naturally-occurring fractal images. *FracTools III* ($79.95) is a DOS-based CD-ROM created by Bourbaki and is best described as an integrated graphics system for generating, playing with and printing an infinite number of fractals or other images. The CD-ROM contains 590 .PCX images for slide shows, screen savers, kaleidoscopes or whatever other use you'd like to make of them. Other graphics formats like, .GIF, .IMG and .BMP, are supported, as are video modes ranging from 320 X 200 X 256 all the way up to 1, 024 X 768 X 256.

PRODUCTS MENTIONED

Pro Audio Studio 16/ProMovie Studio
Media Vision
47300 Bayside Pkwy.
Fremont, CA 94538
Tel.: 510-770-8600

CIRCLE NO 163 ON FREE INFORMATION CARD

America In Motion/Business In Motion
Jasmine Multimedia Publishing
6746 Valjean Ave., Ste. 100
Van Nuys, CA 91406
Tel.: 1-800-798-7535

CIRCLE NO 164 ON FREE INFORMATION CARD

MOST CD-ROMs
Compton's New Media
2320 Camino Vida Roble
Carlsbad, CA 92009
Tel: 619-929-2500

CIRCLE NO 165 ON FREE INFORMATION CARD

MIDI Processing Modules
MIDI Solutions Inc.
816-810 W. Bway.
Vancouver, B.C. Canada V5Z 4C9
Tel.: 604-94-3013

CIRCLE NO 166 ON FREE INFORMATION CARD

Media-Pedia Video Clips
Media-Pedia Inc.
22 Fisher Ave.
Wellesley, MA 02181
Tel.: 617-235-5617

CIRCLE NO 167 ON FREE INFORMATION CARD

Fractal CD-ROMs
Quanta Press, Inc.
1313 Fifth St. SE, Ste. 223A
Minneapolis, MN 55414
Tel.: 612-379-3956

CIRCLE NO 168 ON FREE INFORMATION CARD

Black-Box MIDI Solutions

If you've ever worked with external MIDI devices like synthesizers and tone generators connected to your PC, you're already aware of the incredible power such a setup can produce. More than likely, you've also probably encountered some limitations and/or signal bottlenecks that are inherent when you're connecting multiple devices. MIDI Solutions provides the cure for these ills with its series of eight "black boxes." Each individual black box takes care of a specific task. All of the MIDI Solutions modules are small black "project" cases that are outfitted with a standard five-pin DIN MIDI input connector at one end and at least one MIDI output connector at the other end. No additional power is required because the modules all draw their power directly from the MIDI cable.

The individual MIDI Solutions module lineup includes:

• **Velocity Converter** ($59). This module provides 40 preset velocity curves and one user-definable curve. You can assign a unique curve to each MIDI channel.

• **All-Notes-Off Filter** ($49). This is a very handy module to have if you're using an older MIDI synthesizer (like the Casio CZ-101) that doesn't always respond as you expect it to. This filter eliminates all-notes-off messages (controller #123) from the MIDI data stream.

• **Router** ($59). This module routes MIDI messages to either of two MIDI outputs. Routing can be based on the MIDI message type or the MIDI channel.

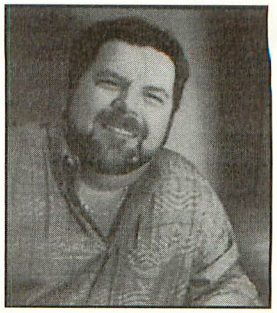
• **Mapper** ($59). With this module, MIDI messages can be mapped from one type to another. Message types include controller, program change, channel pressure and pitch bend. As with the other modules, this one is powered by the MIDI signal and requires no battery or power supply for operation.

• **Thru** ($29). This module provides an inexpensive way of providing two MIDI throughs from a single MIDI input. All MIDI data that appears at the input is sent directly to the Thru outputs.

• **Merger** ($59). Two MIDI inputs can be merged to a single MIDI output wit this module, and all types of MIDI data are merged. This module is great for merging two discrete MIDI sources (like a tone generator and a synthesizer keyboard) into a single data stream for use in a sequencer.

• **Footswitch Controller** ($79). This is a most welcome solution for generating preprogrammed MIDI messages using any footswitch. This module merges these messages with incoming MIDI messages and is quite useful for changing voices (patches), pitch bend, controller and other messages by predefining the system-exclusive program commands.

• **Relay** ($99). This module is a MIDI-controlled relay switch that can be used to replace a footswitch or any other momentary-action connection. The relay functions are programmed into the module using System Exclusive commands (entered in hex), and it can respond to note, controller, program and SysEx changes. The relay's contact ratings are 3 watts, 150 volts, 0.5 ampere and it has a fast-acting 0.5-ampere 3AG fuse to protect your equipment.



Tom Benford

By Steven Sweet

The Real Cost of Upgrading to *Windows* 3.1

Installing *Windows* 3.1 on your system represents only a very humble beginning in terms of what's needed for you to get serious work done under this popular graphical user interface environment.

When the advertisement in your favorite computer catalog or the sign in your local computer store catches your eye with "Upgrade to Windows for $39.95" in big bold lettering, *watch out*! If you plan to take full advantage of *Windows* 3.1's features, you'll need a lot more than thirty-nine dollars and change. In this article, I'll briefly describe some available *Windows* applications and help you to keep a running tally of the actual hardware and software costs of using the virtual Pandora's box of features opened to you when you buy into *Windows* 3.1.

Then and Now

Microsoft first introduced the *Windows* graphical user interface (GUI) in 1985 was an environment designed to sit on top of and enhance DOS. Though it was slow, it didn't demand much from the hardware of the day, running comfortably on even a lowly (by today's standards) XT PC/compatible. It offered a point-and-click command environment as an alternative to having the user type commands at the DOS prompt.

While most programs at the time required only DOS to run, by the time *Windows* 2.0 was released in 1987, software that required and took advantage of the *Windows* platform began to appear in the marketplace. The main idea of *Windows* was to provide a GUI environment with all the graphics, printer and peripheral drivers needed for any installed application software.

Though most desktop PCs in the mid-1980s came with at least 640K of RAM, as the end of the decade approached, PCs were arriving on desktops with more than 640K and required memory-management software to run the new RAM-hungry application software then being marketed. A *Windows* 386 version was added to the shelf to keep up with this trend.

By 1990, *Windows* 3.0 offered a significant upgrade as a new 3D icon-based point-and-click environment, standard dot-matrix and laser printer and VGA video drivers and better use of the computer's RAM beyond 640K. It also offered an optional Multimedia Extensions for *Windows* package. It operated in three modes: "real" mode for XT and 286 PC and compatible computers with only 640K of RAM; "standard" mode for the 286 PC that lacked extended memory; and "enhanced" mode for the 386 and 486 machines with extended memory. Though still slow, and despite its intermittent instability of system-crashing general protection fault errors, more applications began to require the *Windows* platform.

The April 1992 release of *Windows* 3.1, combined with the previous year's release of MS-DOS Version 5.0, made the GUI the fastest-selling and most-popular operating platform for the desktop PC. Features included a comprehensive list of faster and more-stable VGA, SVGA, printer and peripheral drivers; a desktop of useful, though simple, applications, such as paint, word-processing, calendar and game software; TrueType fonts; better memory management that provided virtual elimination of the general protection faults; introduction of Dynamic Data Exchange (DDE) and Object Linking and Embedding (OLE); a faster and enhanced icon-based front end; and inclusion of multimedia support. Since *Windows* 3.1's introduction, many millions of copies of it have been installed on PCs, which, together with its better stability, has caused many vendors to get on the *Windows* bandwagon. This past year has seen the migration of many popular Macintosh products to the *Windows* platform, adding to the hundreds of applications that are now available.

Buyer Beware!

While *Windows* has been undergoing enhancements, so have its requirements been enhanced in terms of the hardware on which it runs. In fact, an XT or 286 PC is currently virtually useless for a *Windows* 3.1 setup. You have to add significantly to the modest entry fee of $39.95 for *Windows* 3.1. You may, in fact, have to bear the expense of upgrading your current system or even replacing it altogether, depending on what applications you're planning to use.

A basic *Windows* 3.1 system should include nothing less than a 386SX PC (the faster the better) with 4M of RAM, at least a 100M hard drive and a 14" color VGA video monitor with 0.28-mm dot pitch. Such a setup is readily available for less that $1,000 from most mail-order houses, with some of these sources even pre-in-

stalling *Windows* and DOS for you. However, *Windows* is most efficient and at its best with at least 8M of RAM. (Due to the fire this summer at the Sumitomo Chemical Co. in Japan, the company responsible for the production of more than 60% of the world's epoxy resin compound used to make integrated circuits, you'll need to figure in at least $75 to $100 per megabyte of additional RAM over and above the base cost of a system.)

When upgrading to *Windows* 3.1, give consideration to the applications you plan to run. *Windows* applications require a large amount of hard-drive space. Simply installing *Windows* and DOS on a hard drive consumes between 15M to 20M of space. A word processor like Microsoft's *Word for Windows* ($495) or WordPerfect's *WordPerfect for Windows* ($495) will eat up another 20M to 25M of disk space for just the program and some font files. Desktop Publishing software like Aldus *PageMaker* ($895), Corel *Ventura Publisher for Windows* ($795) or Quark *QuarkXPress for Windows* ($949) will take up another 20M to 30M of disk space.

An extensive draw/paint and illustration program like Corel's *CorelDRAW!* 3 ($199), *CorelDRAW!* 4 ($595) or Micrografx *Designer* ($495) will up the ante by another 30M to 35M of space for its program and clipart files. A spreadsheet like Microsoft *Excel* ($495) or Lotus *1-2-3 for Windows* ($595) tacks on another 20M to 25M penalty for program, charts and clipart files.

If the you have the slightest inclination of using any of these applications, be sure to factor in the cost of a fast IDE hard drive like the 345M Maxtor 7345A you can get at the time of this writing for about $300.

Windows offers an attractive platform for any aspiring photograph editor on which to do serious professional-level work. Recent releases of image-manipulation software like Aldus *PhotoShop* ($895) and Micrografx *Picture Publisher* ($495) exploit the technological advances of the past year: image file compression, TWAIN and Kodak Photo CD. Using the Joint Photographers Experts Groups (JPEG) image-compression algorithm and its Interchange File Format (.IFF) make more-efficient use of disk storage space, reduce network loading and data communication time and cost.

Diamond Computer's Stealth Pro SVGA video card.

The TWAIN image-acquisition standard developed by Aldus, Caere, Hewlett-Packard, Eastman Kodak and Logitech provides an open industry standard that directly acquires image data from external sources (scanners, cameras, etc.) while the artist stays within a working application. The hardware vendor writes one driver that's compliant to TWAIN, which is supported in the *Windows* application.

Eastman Kodak went on to develop the Photo CD technology that does for photos what the CD did for music lovers. It stores high-resolution images in an easy-to-access and use format. A Photo CD-compliant CD-ROM drive can access more than 100 high-resolution, full-color photos on a single CD-ROM disk.

Epson offers an Action Scanning System ($999) that features the company's ES 600C eight-bit color flatbed scanner capable of 50- to 600-dot-per-inch (dpi) resolution in 23 levels, controlled by an included bidirectional parallel card interface. It includes the TWAIN driver and the Micrografx *Picture Publisher* 4.0 LE (Lite) software sampler. Add Caere *OmniPage Direct* ($199) optical character recognition (OCR) software, and you can save hours of typing by scanning documents into your *Windows* word processor.

Selection of a graphics card is an essential factor in *Windows*' operating speed. *Windows* can slow down significantly when you try to work beyond standard VGA resolution. The PC offers the computer artist four levels of color resolution. Basic VGA is four-bit color capable of displaying 16 colors at resolutions up to 640 x 480 pixels. Super VGA is eight-bit color capable of displaying 256 colors at up to 800 x 600 resolution. HiColor is 16-bit color capable of displaying 32,800 colors at up to 800 x 600. Finally, TrueColor is 24-bit color capable of displaying 16.7-million colors at up to 1, 024 x 768 resolution.

If you wish to work with images in super VGA or higher under *Windows*, it's strongly recommended that you use an Industry Standard Architecture (ISA) high-color accelerator card like the Diamond Computer 1M VRAM Stealth 24 ($295) or 2M Stealth Pro ($449) or STB 1M Powergraph X-24 ($249) with the Sierra Semiconductor HiColor (S3) RAM DAC chip to produce up to 16.7-million colors and significantly speed up a screen's refresh rate. Upon installation, a *Windows* Control Panel icon is created to let you easily switch to desired resolutions. If you're a serious high-resolution *Windows* user, give serious consideration to purchasing a 32-bit VESA Local Bus-compliant (VLB) accelerator card like the Diamond 2M Viper VLB ($499) or STB 4M Pega-

sus VLB ($595) for best and fastest results in your work.

If you plan to use *Windows* in its normal resolution of 16 colors at 640 x 480-pixel resolution, a 14" monitor like the ViewSonic 5E ($599) that supports a 72-Hz refresh rate at all resolutions, which is the Video Electronics Standards Association (VESA) standard, will offer flicker-free viewing comfort. However, when you move into the higher resolutions that display more information on-screen and photorealistic true color, eye strain is the downside on a 14" monitor. While the colors may be truer, type is uncomfortably smaller and more difficult to read. To reduce eye strain, you're better off opting for a 17" monitor like the ViewSonic ($1,299), which offers a flicker-free 76-Hz refresh rate at resolutions up to 1, 280 x 1,024 pixels.

Windows 3.1 comes with multimedia features. In the early 1990s, the Multimedia PC Marketing Council (MPC), made up of vendors, convened with the objective of establishing hardware and software standards for the developing multimedia market. As the technology quickly advanced, the council met again in May of 1993 to split the MPC standards into two levels, as outlined in the Table 1. You should look for the MPC or MPC2 logo to confirm that what you're getting meets these standards.

To use the basic multimedia features included with *Windows* 3.1, you'll have to add the cost of an MPC-compliant sound card, such as the Creative Labs Sound Blaster Basic eight-bit ($99) or MediaVision Pro Audio Basic 16-bit ($199) cards. A PC speaker driver for *Windows* is available from Microsoft, but the sound quality of the average 2" speaker built into the typical PC is lousy, to say the least. Factor in another $50 to $75 for a pair of small self-amplified external speakers to hook up to the sound card. (Philips Consumer Electronics' Brilliance 15 15" SVGA monitor features a built-in stereo amplifier, speakers, headphone jack and user-adjustable volume control for $699, which you can use to free up desktop space otherwise required for external speakers.)

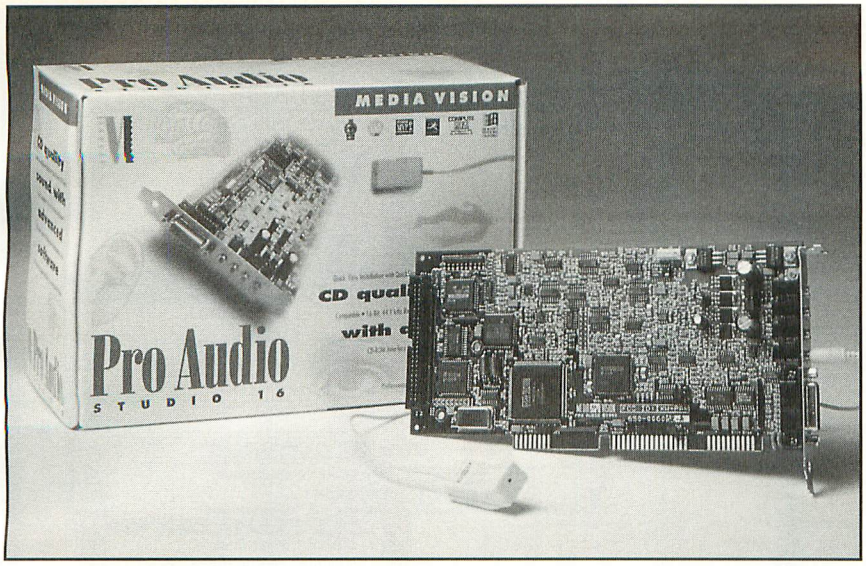
An important—and expensive—part of the multimedia setup is installation of an MPC-compliant CD-ROM drive. If you're intrigued by the features of a multimedia desktop computer and are inclined to get into multimedia, you should aim for the fastest and easiest-to-adapt CD-ROM configuration. CD-ROM drives can be controlled by proprietary controller cards like those offered in Sony's CDU 7205 upgrade kit ($595), which includes the 350-ms CD-ROM drive and a generous collection of CD-ROM titles. Sony also offers a CDU 31A02 ($149) 550-ms internal CD-ROM drive with a $54 proprietary interface. Creative Labs' Sound Blaster Pro ($249) offers a proprietary controller for a Panasonic CD-ROM drive.

CD-ROM drives like the Toshiba TXM 3401 ($700) series that are controlled by the SCSI-2 interface offer the best flexibility, allowing you to daisychain up to seven SCSI devices (hard drives, scanners, CD-ROM drives, etc.) from one controller card that costs from $70 to $200. The Toshiba TXM 3401 double-speed series CD-ROM drives exceeds even MPC Level 2 compliance by offering a 330K/second transfer rate with a 200-ms average access time and a 256K on-board buffer and is CD-ROM XA, multisession and Photo CD-compatible. The Pro Audio Studio ($349) is a 16-bit sound card from Media Vision with an on-board SCSI controller.

Another warning concerns the use of SCSI devices. In the past, using a SCSI connection had a history of compatibility problems. To avoid this, look for the more-compatible SCSI-2 standard, which has eliminated hardware-compatibility problems and boosted performance. Additionally, use of the Advanced SCSI Programming Interface (ASPI) DOS Manager developed by Adaptec, which has near universal industry driver standards, permits easy hookup of any SCSI device to a desktop computer.

Fortunately for the multimedia enthusiast, there are upgrade packages that are virtual plug-and-play installation kits. Media Vision's Fusion Double CD 16 kit ($999) includes the Pro Audio Spectrum 16-bit sound card with SCSI connection to an included 350-ms NEC 55J CD-ROM drive, a pair of Labtec CS550 amplified

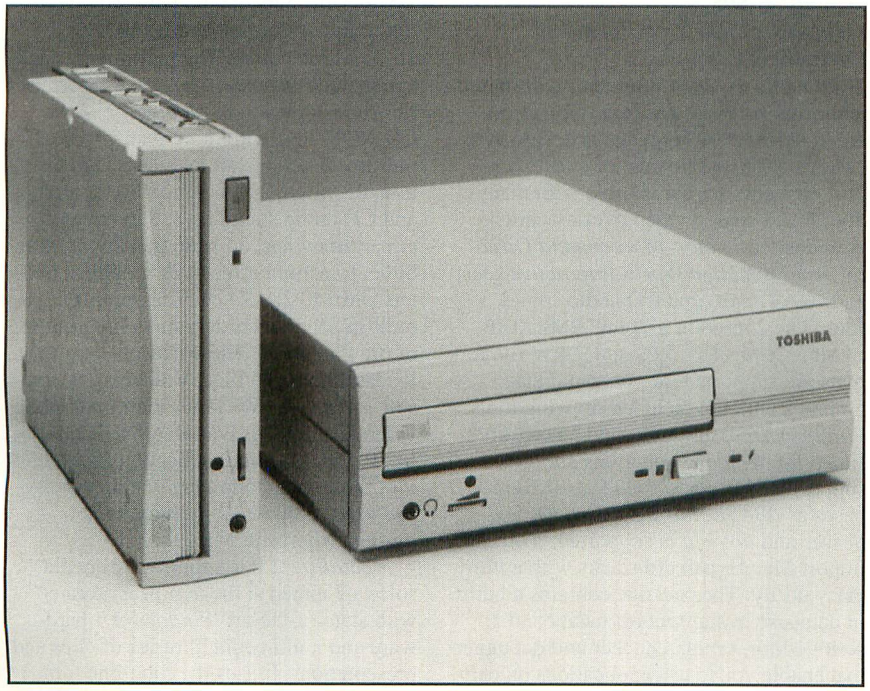
ViewSonic's 5E 14" color video monitor.



Media Vision's Pro Audio Studio 16 16-bit sound card and SCSI adapter.

speakers and CD-ROM titles that include *Compton's Interactive Encyclopedia*, Broderbund's *Living Books*, Interplay's *Battle Chess Enhanced* and Virgin Games *7th Quest*.

Microsoft hasn't been idle in developing the multimedia features of *Windows*. This past year marked the introduction of Microsoft *Video for Windows* ($199), which permits control of digital audio and video for recording and playback in *Windows* applications. It features editing, capture, compression and decompression algorithms and *QuickTime* (Mac) conversion. It uses its own Audio/Video Interface (.AVI) file format and supports OLE to link its video to other software within *Window. Video for Windows* requires a 16-MHz 386SX for playback and a 33-MHz 386 with at least 50M of hard-drive space to record. Creative Labs' VideoSpigot video card ($500) comes packaged with *Video for Windows* and Asymetrix's *Multimedia Toolbook*, *Multimedia Make Your Point* and *MediaBlitz* software.



Toshiba's XM series double-speed CD-ROM drives.

Needless to say, it's essential that all installed hardware be in sync with the *Windows* applications. Each piece of hardware needs a software driver to operate efficiently with the *Windows* GUI. Aris Entertainment helps to accomplish this with its *MPC Wizard 2* CD-ROM ($14.95), which contains multimedia diagnostics; 100M of drivers from virtually every manufacturer of VGA and SVGA graphic cards, sound cards and CD-ROM drives; a collection of eight *Video for Windows* live-action runtime multimedia clips; a sample of 50 photos from the *MediaClips* collection; and 50 sample sound tracks. The diagnostics comprehensively test every aspect of multimedia hardware performance to determine whether the installed system meets the MPC Level 1 or Level 2 specifications. Once tests are run, helpful and specific tips are available to help you configure and tune your multimedia hardware for optimum performance.

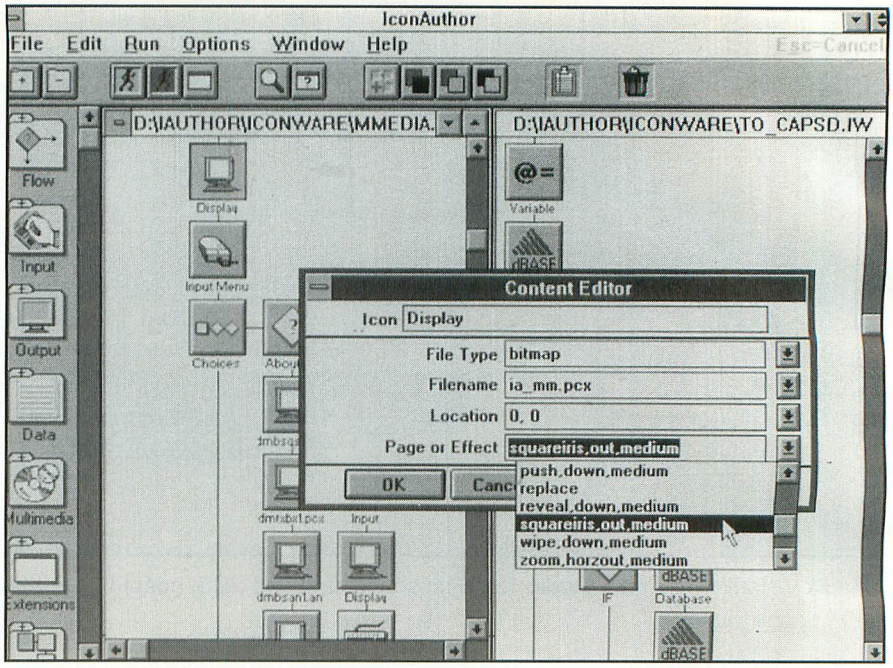
If you want to go beyond basic multimedia features and get into serious development and experimentation, *Windows* 3.1 offers the capacity to proceed boldly into this new computer platform of the 1990s. *Windows* multimedia authoring software pulls together live video (.AVI and .DVI files), sound (.WAV, .MID and .VOC files), computer graphics and animation and text to create a multimedia presentation in much the same way desktop publishing pulls together text and graphics to create camera-ready pre-press material. The hardware required to do this is much more complicated and compatibility-sensitive. It also significantly adds to the cost of upgrading your *Windows* system. Authoring software for *Windows* has an added benefit of being MPC-compliant.

Your multimedia authoring platform ideally should contain a fast 486 computer ($3,000) with 8M of RAM, a 300M hard drive ($300), VGA-to-NTSC video card ($995), a 17" multiscan monitor ($1,500), audio capture/playback card ($250), full-motion video card ($1,500) and video image-capture card ($595). A keyboard, mouse or trackball, tablet or touch screen can serve as the input device.

External hardware should include a flatbed scanner ($800), videodisk player and/or VCR ($500) with NTSC monitor ($250), camcorder ($1,000), CD-ROM player ($700), speakers, MIDI controller ($250), audio cassette recorder/player and a microphone.

Some nifty programs are available to help you create your own multimedia presentations with this $10,00-plus system. The following are thumbnail sketches of multimedia authoring software offered by six major vendors for the *Windows* 3.1 platform.

I reviewed the software described here on a 386 MPC-compliant PC equipped with 8M of RAM, an Optiquest 1000 video monitor driven by an STB PowerGraph X-24 graphics card, Matrox Illuminator 16 video graphics card, 215M Maxtor IDE hard drive and Microsoft Mouse operating under DOS 5.0 and *Windows* 3.1. I also used a Toshiba TXM3401E CD-ROM drive connected to a MediaVision Pro Audio Studio 16 audio card to accommodate CD-ROM disks and sound. An Epson Action Scanning System was also available.



Screen shot from Aimtech's *IconAuthor* multimedia authoring software.

Multimedia Authoring Software

IconAuthor 5.0 ($4,995)
(AimTech Corp.)
The intuitive *IconAuthor* package utilizes a flowchart of icon tools to speed development of interactive presentations. It requires little programming or scripting skills. (A non-audio/video enhancement version is available for $2,495.) The Package includes six run-time modules, which cost another $50 each.

Presentations are developed by creating structures and then adding content to the structures with icons that represent functions or tasks. ASCII text files; .PCX, .WMF, .RLE, .DIB and .BMP graphics files (up to 24-bit color); .WAV, .MID and CD audio files; animation and full-motion video files can be included as content using icon dialogue boxes, each with its own editor. IconAnimate, a full animation scripter and a full graphics module with WYSIWYG editors are included. You can run, test and edit presentations in realtime.

Sony, Phillips, Pioneer and Panasonic videodisc players and tape players; IBM, Sony and VideoLogic video overlay cards; Online, Video Associate Labs, Media Vision and Creative Labs audio cards are supported.

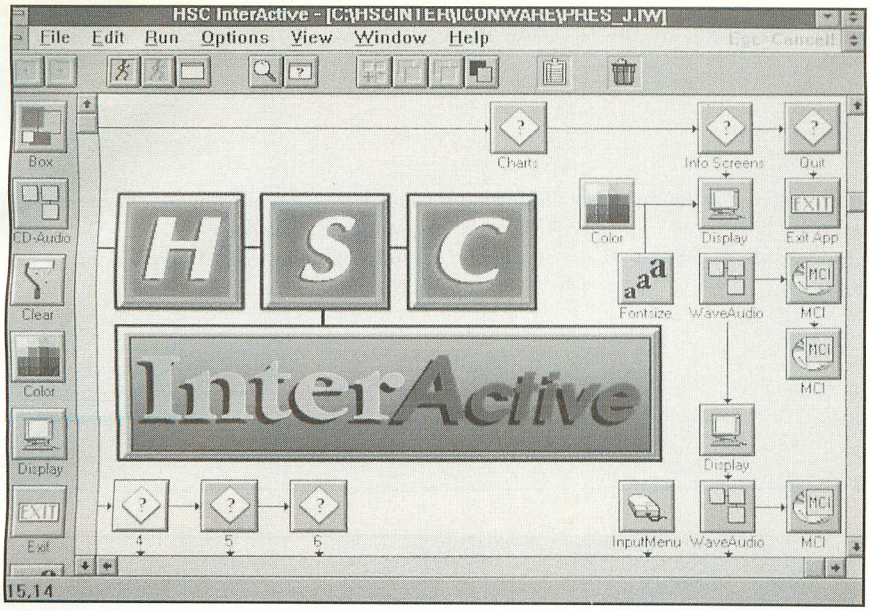
New features include a new Smart Object Editor; enhanced *Windows* OLE, DDE and DLL support; a new graphical debugger; extensive digital video support for IBM-Intel's DVI (Digital Video Interactive) and Indeo, Microsoft's *Video for Windows* and Fluent's *Fluency; IAScope* that permits visual tracing of problems; and ASCII and .RTF file support and *Windows* for Pen Computing.

Multimedia Toolbox, $695
Compel, $295
MediaBlitz, $95
Multimedia Make Your Point, $89
(Asymetrix Corp.)
Multimedia Toolbox is another icon-based authoring software package. Object-oriented *OpenScript* language is designed to ease creation and linkage of events. Import elements are compatible with many digital and analog video overlay cards; Autodesk *Animator*, *Macromedia Director* and *Animation Works Interactive* files; and .WAV, .MID and CD audio sound files. The 256-color graphic .BMP, .DIB, .WMF, .CGM, .TIF, .EPS and .DRW file formats are supported, or you can create graphics with the included drawing tools. *Windows* DDE and DLL and Microsoft's *Video for Windows* functions are fully supported. Access to such flat-file databases as *dBASE*, *Paradox*, *Oracle*, *SQL Server* and *dbVista* is supported. You can import Mac Hypercard stacks with a third-party utility. The package contains a built-in database to sort records easily and a script editor, syntax checker and debugger that enable you to test applications quickly.

A built-in recorder translates user actions into scripts that are stored and rerun. Printing support lets you generate hard copy of presentations. Hypertext hotwords or buttons can be linked to text, audio, video, animation and graphics. A run-time version provides distribution of presentations. Context-sensitive help is always available. An included CD-ROM disc provides more than 270 pre-scripted multimedia objects and clip files.

Compel 1.0 offers quick creation of interactive multimedia. It lets you import .BMP, .DIB, .EPS, .PCX, .GIF, .TIF, .DXF, .PICT and .PIC graphics files in 256 to 16.7-million colors. The multimedia package includes *Compel Show* as a *Windows* run-time application; *Mediablitz!* 2.0; a CD-ROM disc with more than 100M of multimedia clips that include 30 animation, 25 video, 200 sample .WAV, .MID and CD audio sound files, 350 editable clipart drawings, 34 slide transitions, nine bullet transition effects, 29 graphical bullets and 340 2D/3D charting templates; a built-in sound recorder; and a full palette of drawing tools. There's also support for Kodak Photo CD files, Videodisk, Microsoft's *Video for Windows* with Intel Indeo video technology, *Windows* OLE and MAPI (Messaging Application Programming Interface), allowing you to package and send multimedia presentations through Microsoft Mail.

MediaBlitz 2.0 is simple multimedia software aimed at the non-programmer with state-of-the-art *Windows* 3.1 hardware and multimedia libraries of clips and presentations. It uses the time-line format and three modules for creating and editing presentations. A Clipmaker module cre-



Opening screen from HSC's *HSC Interactive* multimedia authoring software.

ates links between CD audio, .MID and .WAV sound and animation clips from *3D Studio*, *Macromedia Director* and *Animation Works* and up to 256-color bitmap graphics. Scoremaker involves placing the "Clips" on a time line with interactive characteristics. Microsoft's *Video for Windows* and *Windows* DDE and OLE are fully supported, as are MAPI-compliant e-mail programs. You can run presentations through ScorePlayer as an information kiosk or from within a separate *Windows* application. This package includes more than 10M of multimedia clips files.

Make Your Point is the simplest of the Asymetrix products. It uses a text-based metaphor of a bullet-list presentation and 30 pre-designed templates to create a simple presentation. Graphic files in the .BMP, .CGM, .DIB, .DRW, .EPS, .TIF and .WMF formats can be used. Only one graphic, *3D Studio Director* or *Animator* animation clip or .WAV, .MID or CD audio sound can be linked to any button on the presentation screen at a time. You can print template screens with bullet points, titles, speaker notes and included graphics. Presentation screens that contain imported elements can't be saved as files or printed, and a run- time version can't be created.

Animation Works Interactive, $495
AddImpact!, $150
(Gold Disk. Inc.)
Animation Works Interactive 2.0 consists of three modules: Background Editor, Cel Editor and Movie Editor. Background Editor creates backgrounds with a full set of paint tools and permits you to import 256-color scanned images and .BMP, .PCX, .RLE and .FLI bitmap and .TIF, .TGA and .CGM files. Cel Editor creates "actors," such as titles, logos, charts and graphics files, for importing and combining with backgrounds to the Movie Editor vector-based path controller. *Windows* DDE and OLE are supported.

Frame-based animation contains events to include playback of sound (.WAV, .MID or CD audio) or digitized video. A sound driver for the internal PC speaker is included for playback of .WAV sound files. MCI compatibility permits integration of laserdisc players, VCRs, DVI cards and CD-ROM players. An interactive facility permits triggering of programmed events using keyboard or mouse. A Translation tool accesses any *Windows*-scalable True-Type or Adobe Type 1 typeface. A Movie Player utility facilitates run-time playback.

AddImpact! relies heavily on the *Windows* 3.1 OLE feature to embed animation and sound directly into an object icon written into other OLE-compatible programs like *Power Point*, *Quattro Pro*, *AmiPro*, *Excel*, *CorelSHOW*, *CorelDRAW*, *Lotus Notes*, *Windows Write* and Microsoft *Word*. A driver for the standard PC speaker is included. Supported are 256-color .BMP, .PCX, .TIF, .DIB, .GIF and .RLE graphics files. The program also includes a library of 130 animation and 50 movie clips and .WAV and .MID sound effects and a run-time utility.

HSC Interactive, $495
(HSC Software, Inc.)
HSC Interactive 1.0 uses icon-based visual programming techniques to combine 256-color .WMF, .PCX, .RLE and .BMP graphics; live-motion video; ASCII text; *3D Studio* and *Animator* animation flics; and .WAV, .MID and CD audio sound to produce interactive multimedia presentations. Provided are a paint/draw HSC Graphics Editor to create graphics files and the path-based IconAnimate program to animate .PCX, .BMP and .RLE graphic files. A RexSolution module provides screen capture and permits changing bitmap graphic resolution to adjust to different playback systems. Overlay features permit graphics, text and video to be combined on the same screen. An HSC run-time module permits full-screen or windowed play of presentations to indepen- dent sites. *HSC Interactive* is basically a scaled-down and less-expensive version of Aimtech's *IconAuthor* for non-programmers.

Action!, $99
Authorware Pro, $4,995
(Macromedia, Inc.)
Action! 2.5 consists of three principal tools. Action Tool imparts movement to any object. Sound Tool enables sound over time. Linking Tool creates interaction among objects. You're provided with three ways to view and work: a Timeline that gives a graphical view of the whole animation over a period of time; a Scene Sorter for re-ordering scenes; and a Content List for editing and changing different elements within scenes. *Windows* DDE functions are supported.

Action! imports graphics files in the .PCT, .PIC, .BMP, .DIB, .DRW, .EPS, .GIF, .PCX, .TIC, .TGA and .TIF formats and .MMM files produced with Macromedia's *Director for the Mac*. It attaches .WAV, .AIF, .PCM, .MID and CD audio sound formats to animation sequences.

Supplied is a CD-ROM library of media clips, including animations, sounds, clip-art and 100 ready-to-use templates. Scalable fonts via TrueType and *Adobe Type Manager* (included) provides text. A *Windows* Player run-time module is included, and screens can be printed or sent directly to videotape with compatible hardware.

Version 2.5 offers updated player application; digital video that supports Microsoft's *Video for Windows* (.AVI), Apple's *QuickTime for Windows* and Intel's DVI, Media Vision's ProMovie Spectrum and Creative Lab's Video Blaster cards; and Autodesk's .FLI and .FLC animation files.

Authorware Professional 2.0 is high-end multimedia authoring package that contains a full-animation and graphics editor. It brings together .WMF, .PCX, .BMP, .DRW and .PIC graphics with .WAV, .MID and CD audio and .SND, .AIFF and .PCM audio files; .FLI and .FLC animation files; TrueType fonts for text; still and full-motion video to create interactive presentations. Files created on the Mac can be edited under *Windows* and *vice-versa*. Micirosoft *Video for Windows*, Intel's Indeo and *Windows* DDL are supported.

An interface for IBM's M-Motion, RasterOps, Radius and VideoLogic video-

Table 1. Multimedia PC Level 1 and Level 2 Specifications

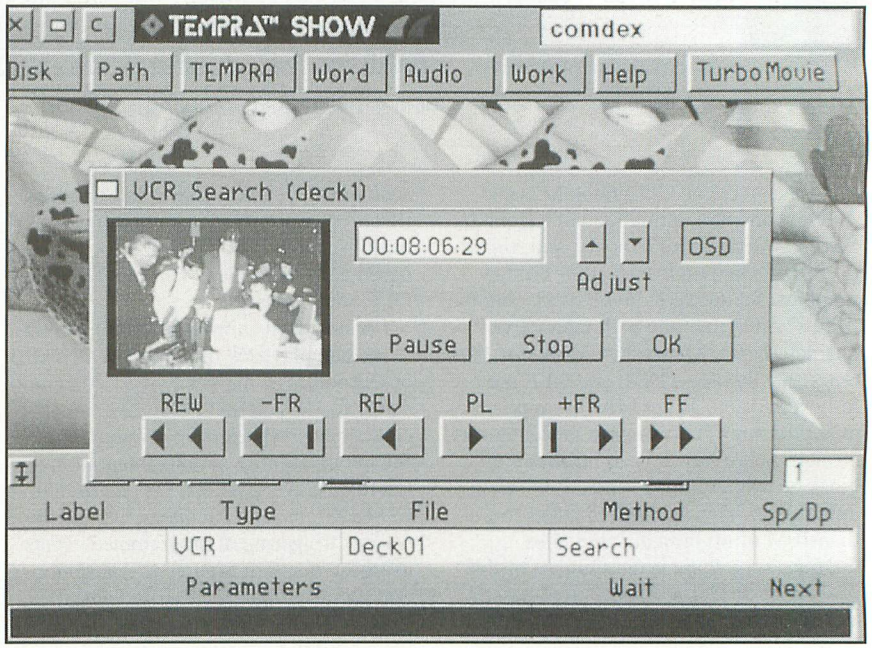
Minimum Required	**Level 1**	**Level 2**
RAM	2M	4M
Processor	16-MHz 386SX	25-MHz 486SX
Hard Drive	30M	160M
CD-ROM Drive	150K/second sustained transfer, maximum average seek time 1 second	300K/second sustained transfer, maximum average seek time 400 ms, multisession capable
Sound Card	Eight-bit, eight-note synthesizer, MIDI play	16-bit digital, eight-note synthesizer, MIDI play
Video Display	640 x 480 at 16 colors	640 x 480 at 65,536 colors
Recommendations		
RAM		8M
CD-ROM Drive	64K on-board buffer	64K on-board buffer
Sound Card		CD-ROM XA audio, IMA support with ADPCM algorithm
Video Display	640 x 480 at 256 colors	Delivery of 1.2M pixels per second, given 40% of CPU bandwidth

overlay card and control of MPC and Ultimedia sound and video devices is supported. Also supported are Sony, NEC, Panasonic and Pioneer video devices and IBM M-audio, Sound Blaster and MediaVision audio cards.

The program lets you build multimedia applications without knowledge of the Lingo scripting language by arranging icons along a flow line. A new Media Manager module creates a library database of all elements of the presentation as individual icons.

Media Author, $1,995
Tempra Show, $295
(Mathematica, Inc.)
Media Author is a multimedia package that can operate under DOS, *Windows* 3.1 and OS/2. It includes the *Tempra Pro* photorealistic 16.7-million color image-editing software with scanning, video-capture and full drawing tools features and imports eight- to 24-bit color files; a *Turbo Animator* eight-bit .FLC and .FLI animation editor and eight-bit .FLC and 16-bit .FLX animation creator that permits capture of realtime video with accurate videotape, videodisc and Sony VISCA support; and a *Tempra Access* add-on for Kodak Photo CD support and database-management functions. Turbo processes files at five to ten times faster than other imaging products. Finished productions can be distributed on the included run-time version.

Tempra Show is intuitive multimedia authoring software that provides all the tools needed to create interactive multimedia presentations that integrate eight- and 16-bit color .GIF, .BMP, .MID and CD audio files; .FLI and .FLC animation files; ASCII text using 30 Bitstream fonts; special effects and video. Included are Tempra Pro and Tempra GIF imaging editors, as well as a TshowRun run-time module for distribution of presentations. Video in a window and print to video are supported and will use touch screens, keyboard or mouse for interactive features. Sony VICSA interface and Video Blaster, Cardinal SNAPPlus and Sound Blaster-compatible cards are supported.



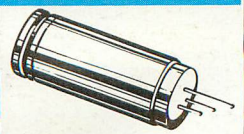
Screen shot from Mathematica's *Tempra Show* multimedia software.

Final Tally

If you have had a pencil and paper handy to tally up the true costs of upgrading to *Windows* 3.1 while reading this article, keep in mind that most of the prices mentioned here are manufacturer suggested retail prices. "Street" prices run between 40% to 60% less and may be more manageable for you with a call to your local discount computer supply store or some popular and reliable mail-order houses like Altex Electronics (800-531-5369), CompuAbility (800-554-9982), Computer Discount Warehouse (800-829-4239), Micro Warehouse (800-367-7080), PC Connection (800-800-5555) and PC Zone (800-258-2088).

In this article, I've given you only a brief view of the type of hardware and software currently available for working with *Windows*. Some technical and mechanical aptitude and confidence would be required to install the hardware and software mentioned. If you don't want to get under the hood of your desktop computer, some vendors package *Windows* systems that are virtual plug-and play-setups. For a mere $999, Wearnes Technology Corp. (800-822-8884) offers an MPC-Level 1-compliant system that fea-

Collimator Pen



Output: 2.5 mW (max.); Current: 90-150 mA
Oper. Volt: 2.2-2.5V; WL: 820nm – Infrared
Size: 11mm dia. x 27mm long; Data sheet inc.

STOCK#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

Collimating Lens

Black anodized aluminum barrel; Glass lens with 7.5mm focal length.
Fits 9mm laser diodes sold below.
Easy to focus and install.

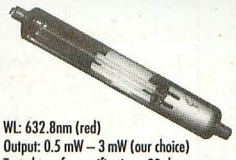
STOCK#	1-9	10-24	25+
LSLENS	24.99	23.74	21.37

Dual Mode Laser Pointer

Weighs less than 2 oz.; 0.5" dia. x 6.25" long
WL: 670nm @ <1 mW (6mm beam)
Switch from continuous to pulse mode.
Uses 2 AAA batteries (inc.); 1-year warranty.

STOCK#	1-9	10-24	25+
LP35	199.99	189.99	170.99

He-Ne Laser Tube



WL: 632.8nm (red)
Output: 0.5 mW – 3 mW (our choice)
Tested to mfr. specifications; 30-day warranty.

STOCK#	1-9	10-24	25+
LT1001	69.99	66.49	59.84

He-Ne Laser Pointer

7.2" L x 1.4" W x 2.2" H; Weighs just 12 oz.
WL: 632.8nm @ <1 mW (8mm beam)
Energized at 5kV, 1.2kV continuous.
Inc. batteries, pouch, guide, 1-year warranty.

STOCK#	1-9	10-24	25+
LP100	199.99	189.99	170.99

Laser Pointer

Just 0.75" dia. x 5.25" long; 670nm @ 3.5 mW
2.5-3.5" beam @ 100 yards
Uses 2 AAA batteries (inc.); 1-year warranty.

STOCK#	1-9	10-24	25+
LSPOINTER	159.99	151.99	136.79

16 More Reasons To Believe In Unicorn

PLUS

Low Prices

•

Super Selection

•

Prompt Service

•

FREE Shipping*

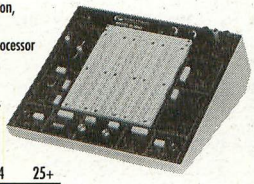
Call Toll Free
(800) 824-3432

Economy Laser Pointer

0.75" dia. x 5.6" long; Weighs less than 3 oz.
670nm @ 1.9 mW (4mm x 0.6mm beam)
Batteries included; 1-year mfr. warranty.

STOCK#	1-9	10-24	25+
LP3	129.99	123.49	111.14

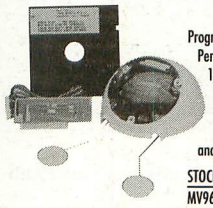
Protoboard Design Station



Includes expanded instrumentation, breadboard, and power supply.
Ideal for analog/digital/microprocessor circuits. Frequency and function generators, variable outputs, logic indicators, speaker & more.
Size: 11.5" L x 16" W x 6.5" H
Weighs 7 pounds.

STOCK#	1-9	10-24	25+
PB503	299.99	284.99	256.49

WAO II Programmable Robotic Kit



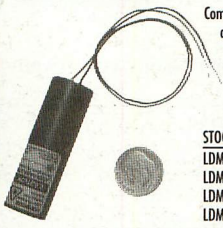
Programmed directly via attached keypad.
Pen mechanism draws text and graphics.
128x4 bits RAM and 2K ROM included.
Uses 3 AA batteries (not included).
Optional Apple computer interface kit includes software, cable, card, and instructions.

STOCK#	1-9	10-24	25+
MV961	79.99	75.99	68.39
WIIAP (interface)	39.99	37.99	34.19

Laser Diodes

Stock#	Mfr.	WL	Output	Oper. Current	Oper. Voltage	1-9	10-24	25+
LS9220	Toshiba	660nm	3 mW	85 mA	2.5V	129.99	123.49	111.14
LS9200	Toshiba	670nm	3 mW	85 mA	2.3V	49.99	47.49	43.19
LS9211	Toshiba	670nm	5 mW	50 mA	2.3V	69.99	66.49	59.84
LS9215	Toshiba	670nm	10 mW	45 mA	2.4V	109.99	104.49	94.04
LS3200	NEC	670nm	3 mW	85 mA	2.2V	59.99	56.99	51.29
LS022	Sharp	780nm	5 mW	65 mA	1.75V	19.99	18.99	17.09
SB1053	Phillips	820nm	10 mW	90 mA	2.2V	10.99	10.44	9.40

Laser Diode Module



Complete with collimating optics and drive electronics.
WL: 660-685nm @ 0.5, 1, 2, or 3 mW
Adjustable focal length.
Connects to 3-5.25 VDC.
Compact size: 0.64" dia. x 2" long.

STOCK#	1-9	10-24	25+
LDM135-.5 (.5mW)	179.99	170.99	153.89
LDM135-1 (1mW)	189.99	180.49	162.44
LDM135-2 (2mW)	199.99	189.99	170.99
LDM135-3 (3mW)	209.99	199.49	179.54

1/4-Ton IDC Bench Assembly Press

Rotating base plate and platen. No tools required to change plates/cutting accessories. Additional accessories available.
Weighs 5.5 lbs.
10" L x 8.75" W x 9" H

STOCK#	1-9	10-24	25+
PV505	149.99	142.49	128.24

Robotic Arm Kit

Fascinating and educational, with lift/lower, grab/release, and pivot left/right functions.
Uses 2 C batteries (not inc.); Apx. 10" long.

STOCK#	1-9	10-24	25+
YO1	43.99	41.79	37.61

41 Watt Switching Power Supply

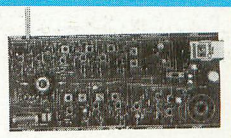
Input: 115/230V
Output: 5V @ 3.75A, 12V @ 1.5A, -12V @ 0.4A
Size: 7" L x 5.25" W x 2.5" H

STOCK#	1-9	10-24	25+
PS1003	19.99	18.99	17.09

EPROMS

STOCK#	1-24	25-99	100+
2764	3.49	3.32	2.99
27128	4.99	4.74	4.27
27256	4.59	4.36	3.92
27C256	4.09	3.89	3.50
27512	5.49	5.22	4.70
27C512	5.49	5.22	4.70
27C1024	8.99	8.54	7.69
27C2048	14.99	14.24	12.82

AM/FM Radio Kit



Includes assembly/lesson manual.
11.6" L x 5.25" W PC board; Superheterodyne receiver.

STOCK#	1-9	10-24	25+
AMFM108	29.99	28.49	25.64

Order Line —
(800) 824-3432
International Orders —
(818) 341-8833
Fax Orders —
(818) 998-7975
Technical Support —
(818) 341-8833

DANGER
LASER LIGHT—AVOID DIRECT EYE EXPOSURE

UNICORN ELECTRONICS

10010 Canoga Avenue, Unit B-8
Chatsworth, CA 91311

VISA MasterCard

- We Carry A Complete Line Of Electronic Components
- Minimum Order — $15.00
- UPS Blue, Red, & Federal Express Shipping Available
- Open Mon-Fri 9:00 am-5:00pm (PDT)
- CA Residents Add 8¼% Sales Tax
- Corporate Accounts / Quantity Discounts Available
- Call For FREE Catalog ($2.00 Outside U.S.)

*FREE Shipping On Pre-Paid Orders Delivered In The Continental United States

CIRCLE NO. 105 ON FREE INFORMATION CARD

Sources

Hardware
Adaptec Corp.
691 S. Milpitas Blvd.
Milpitas, CA 95035
Tel.: 408-945-8600

CIRCLE NO. 120 ON FREE INFORMATION CARD

Sound Blaster
VideoSpigot
Creative Labs, Inc.
2050 Duane Ave.
Santa Clara, CA 95054
Tel.: 408-428-6622

CIRCLE NO. 121 ON FREE INFORMATION CARD

Stealth 24, Stealth Pro
Diamond Computer Systems
1130 East Arques Ave.
Sunnyvale, CA 94086
Tel.: 408-736-2000

CIRCLE NO. 122 ON FREE INFORMATION CARD

ES 600C
Epson America
20770 Madrona Ave.
Torrance, CA 90503
Tel.: 310-782-0770

CIRCLE NO. 123 ON FREE INFORMATION CARD

Illuminator 16/AT
Matrox Electronic Systems
1055 St. Regis
Durval, Quebec, CN H9P 2J4
Tel.: 514-685-2630

CIRCLE NO. 124 ON FREE INFORMATION CARD

7345A IDE Hard Drive
Maxtor Corp.
2190 Miller Dr.
Longmont, CO 80501
Tel.: 303-651-6000

CIRCLE NO. 125 ON FREE INFORMATION CARD

Pro Audio Spectrum 16
Pro Audio Studio 16
Fusion Double CD 16
Media Vision, Inc.
47330 Baysville Pkwy.
Fremont, CA 94538
Tel.: 510-770-8600

CIRCLE NO. 126 ON FREE INFORMATION CARD

CDU 7205/CDU 31A02
Sony Corp. of America
655 River Oaks Pkwy.
San Jose, CA 95134
Tel.: 714-826-6410

CIRCLE NO. 127 ON FREE INFORMATION CARD

Powergraph X-24, VL-24
Pegasus VLB
STB Systems, Inc.
1651 North Glenville
PO Box 850957
Richardson, TX 75085-0957
Tel.: 214-234-8750

CIRCLE NO. 128 ON FREE INFORMATION CARD

TXM 3401
Toshiba America, Inc.
Disk Products Div.
9740 Irvine Blvd.
Box 19724
Irvine, CA 92713-9724
Tel.: 714-583-3000

CIRCLE NO. 129 ON FREE INFORMATION CARD

ViewSonic 5E, 7
Viewsonic, Inc.
Keypoint Technology Corp.
20480 Business Way
Walnut, CA 91789
Tel.: 909-869-7976

CIRCLE NO. 130 ON FREE INFORMATION CARD

Software
IconAuthor
AimTech Corp.
20 Trafalgar Sq.
Nashua, NH 03063-1973
Tel.: 603-883-0220

CIRCLE NO. 131 ON FREE INFORMATION CARD

PhotoShop
PageMaker
Aldus Corp.
411 First Ave. S.
Seatle, WA 98104-2871
Tel.: 206-622-5500

CIRCLE NO. 132 ON FREE INFORMATION CARD

MPC Wizard 2.0
Aris Entertainment, Inc.
310 Washington Blvd., Ste. 100
Marina del Rey, CA 90292
Tel.: 310-821-0234

CIRCLE NO. 133 ON FREE INFORMATION CARD

Multimedia Toolbox
Compel
MediaBlitz
Make Your Point
Asymetrix Corp.
110 110 Ave., Ste. 700
Bellevue, WA 98004
Tel.: 206-637-1500

CIRCLE NO. 134 ON FREE INFORMATION CARD

OmniPage Direct
Caere Corp.
100 Cooper Ct.
Los Gatos, CA 95030
Tel.: 408-395-7000

CIRCLE NO. 135 ON FREE INFORMATION CARD

CorelDRAW! 3 & 4
Corel Ventura Publisher
Corel Corp.
1600 Carling Ave.
Ottawa, Ontario, CN K1Z 8R7
Tel.: 613-723-8200

CIRCLE NO. 136 ON FREE INFORMATION CARD

Photo CD
Eastman-Kodak, Co.
343 State Rd.
Rochester, NY 14650-0519
Tel.: 800-242-2424

CIRCLE NO. 137 ON FREE INFORMATION CARD

Animation Works Interactive
AddImpact!
Gold Disk, Inc.
5155 Spectrum Way, Unit 5
Mississauga, Ontario, CN L4W 5A1
Tel.: 416-602-4000

CIRCLE NO. 138 ON FREE INFORMATION CARD

Interactive
HSC Software, Inc.
1661 Lincoln Blvd., Ste. 101
Santa Monica, CA 90404
Tel.: 310-392-8441

CIRCLE NO. 139 ON FREE INFORMATION CARD

Lotus 1-2-3 for Windows
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
Tel.: 617-577-8500

CIRCLE NO. 140 ON FREE INFORMATION CARD

tures a 16-bit sound card, Labtec CS-150 speakers, a 386SX computer with 4M of RAM, 100M hard drive, 3½" high-density floppy drive, 14" VGA video monitor and Philips CD-ROM drive. Swan Technology (800-554-6746) offers MPC Level 1 and Level 2 plug-and-play systems ranging in price from $1,499 to $2,999 and featuring up to VESA local-bus SVGA cards, multisession double-spin CD-ROM drives, 16-bit sound cards and 486 processors packaged with a generous assortment of CD-ROMs.

As you've seen here, the $39.95 asking price for the *Windows* 3.1 upgrade package is only a modest beginning. Costs can mount precipitously as you consider what applications to run on your *Windows* platform. If you're the kind of computer user who might want

Action!
Authorware Pro
Macromedia, Inc.
600 Townsend St., Ste. 310W
San Francisco, CA 94107
Tel.: 415-442-0200

CIRCLE NO. 141 ON FREE INFORMATION CARD

Media Author
Tempra Show
Mathematica, Inc.
402 S. Kentucky Ave.
Lakeland, FL 33801
Tel: 813-682-1128

CIRCLE NO. 142 ON FREE INFORMATION CARD

Picture Publisher
Micrografx Corp.
1303 Arapaho Rd.
Richardson, TX 75081
Tel.: 214-234-1769

CIRCLE NO. 143 ON FREE INFORMATION CARD

MS DOS 5.0, 6.0
Windows 3.1
Word for Windows
Video for Windows
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 800-426-9400 or 206 936-8661

CIRCLE NO. 144 ON FREE INFORMATION CARD

1730 M St. NW, Ste. 707
Washington, D.C. 20036
Tel.: 202-331-0494

CIRCLE NO. 145 ON FREE INFORMATION CARD

Quark, Inc.
300 S. Jackson St.
Denver, CO 80209
Tel.: 303-934-2211

CIRCLE NO. 146 ON FREE INFORMATION CARD

Wordperfect for Windows
Wordperfect Corp.
1555 N. Technology Way
Orem, UT 84057-2399
Tel.: 801-222-4050

CIRCLE NO. 147 ON FREE INFORMATION CARD

Video Electronics Standards Assn.
2150 N. First St., Ste. 440
San Jose, CA 95131-2020
Tel.: 408-435-0333

CIRCLE NO. 148 ON FREE INFORMATION CARD

to continually enhance your use of *Windows* applications, you're be best advised to get a computer that's easily upgradeable to accommodate your enticement by present and future *Windows* products. A bottomless source of finances might also help.

By Eddie R. McMullen

Use a Parallel Port to Make Voltage Measurements

This project lets you take advantage of the bidirectional parallel port on your PC to do something useful other than print documents and graphics

The parallel port for the PC was originally intended to implement the industry-standard Centronics printer interface. This concept has turned out quite well, as evidenced by the myriad of printers supported by the PC. A more-general view of the parallel port as four output, seven input and eight bidirectional signals (yes, the data lines are actually bidirectional) lets you define many useful circuits that can be interfaced to the parallel port. The main advantage of using a parallel-port interface is that you don't use up a valuable card slot on your PC's expansion bus for the application. Laptop and palmtop PCs with parallel ports are prime candidates for this type of use. Parallel-port interfaces aren't limited to the digital world, either. Multichannel analog-to-digital (A/D) and digital-to-analog (D/A) converters can be realized by circuitry controlled via a parallel port.

The parallel port won't suffice for all applications, of course, since only a certain number of signals are available and there are speed limitations to using a parallel port. Nevertheless, there are many situations in which a parallel port interface will perform the required task quite efficiently. The focus of this article is on use of the parallel port to interface to a single voltage input A/D converter board that will be used to measure temperature at a remote location. Separate boards for the parallel-port-controlled A/D converter and the temperature sensor are presented to make the design generic. This lets you substitute your own voltage-measurement board design for the temperature board described here if you wish to measure a parameter other than temperature.

A serial A/D converter chip makes it possible to implement an A/D board with a few parallel-port bits. In contrast to the bus-oriented A/D converter chip that requires at least an eight-bit microprocessor bus-type interface (a minimum of 11 signals), the serial A/D chip requires a maximum of four interface signals from the host system. Serial A/D chips require fewer interface signals and consume less power. The down side is that they operate at slower speeds than their bus-oriented counterparts. The interface signals for the serial A/D converter include:

- *Chip Select.* This signal starts the A/D conversion process when it goes low. The process will be reset when this signal goes high.
- *Clock.* This signal controls clocking of the serial data. If the chip requires initialization data, the clock signal clocks the input data signal into the chip, which clocks the A/D result on the output data signal from the chip.
- *Input Data.* Not all serial A/D chips have this signal. It's needed only if the chip requires initialization data, which is clocked into the chip by transitions of the clock signal.
- *Output Data.* The results of A/D conversion are serially shifted out on this line, which is shifted one bit at a time by transitions on the clock line.

Linear Technology manufactures a very complete line of serial A/D converter chips. The 10-bit single-input LTC1092 is used here for simplicity and economy. Ten- and 12-bit serial A/D chips, some with the ability to input up to eight analog voltages via on-chip multiplexers, are available from Linear Technology. If you want to learn more about serial A/D converters, I suggest that you purchase the Linear Technology databook.

Table 1 lists the utilized parallel-port signals. These can be accessed on the 25-pin parallel-port connector at the rear of any PC. Parallel-port output pins 1 and 2 and input pin 11 are needed for this application. Pin 1 provides chip select to the LTC1092, pin 2 the clock. Pin 11 receives the serial data. Three ground points are utilized to permit use of a twisted-pair parallel-port cable between the A/D converter board and parallel port.

About the Circuit

Shown in Fig. 1 is the schematic diagram of the temperature-sensor board. The voltage output of this board is based on LM335 temperature-sensor chip *U1*. The transfer function of the LM335 is 10 mV/°C. The outputs of the LM335 at –273° and 100° C (212° F) are 0 mV and 3.73 volts, respectively. This voltage scaling is ideal for applying to an A/D board a full-scale input of 5 volts. A 10,000-ohm potentiometer (*R2*) is included in the circuit to permit precise calibration if this is what you wish. The manufacturer recommends that *R2* be adjusted at an ambient temperature of 25° C to yield an output of 2.982 volts. If you don't require extreme accuracy, you can eliminate *R2*. LM335s are generally good to an accuracy of 1° C without calibration.

Figure 2 is the schematic of the A/D board. LTC1092 serial A/D chip *U1* makes for a very simple design. The +7- to +20-volt dc input to *U1* is

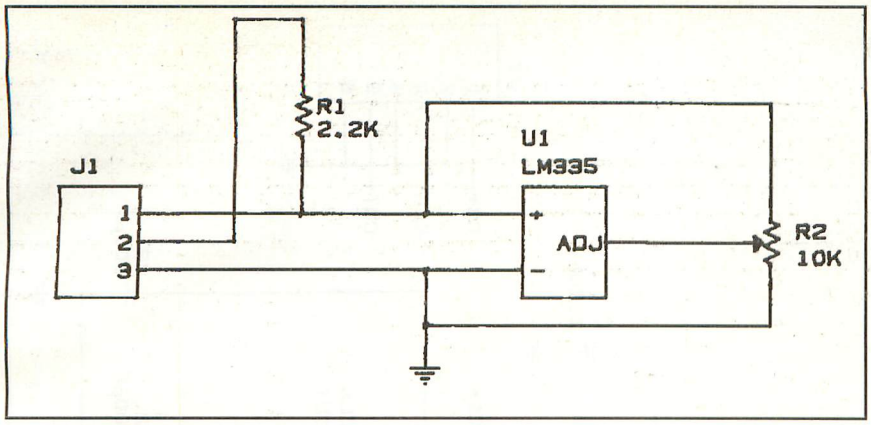


Fig. 1. Schematic diagram for circuitry on temperature-sensor board.

regulated to +5 volts by LTC1021-5 precision voltage reference *U2*. The fact that *U1* consumes only 2.5 mA of current makes for a very simple power-distribution system without all the headaches inherent in high-current A/D boards.

Relatively simple parallel-port programming lets you activate the conversion process by lowering CS* at pin 1 of *U1* and fetching the data in 10-bit serial fashion on OUT pin 6 by clocking CLK pin 7. Raising CS* resets the process. Temperature can then be calculated from the 10-bit serial output of the LTC1092.

Since maximum input to *U1* is set at 5 volts and the maximum number of steps that can be represented by a 10-bit A/D converter is 1,024, voltage resolution of our A/D system is 5 volts divided by 1,024, or approximately 5 mV/bit. Since the output of the LM335 *U1* temperature sensor in Fig. 1 is 10 mV/°C, temperature-measurement resolution of the A/D system is approximately 0.50°C. This means that the smallest change in temperature that the system can recognize is 0.50°C.

A tradeoff exists in the A/D board design. The LTC1092 requires the clock input to be a minimum frequency of 10 kHz. Thus, the software must be able to pulse the clock line once every 100 µs, a timing requirement that Interpreted BASIC can't meet. However, C and assembly language can meet it. I had the choice of adding a few extra chips in the design and, thus, add expense and complexity to the board, to enable you to program in BASIC or keep the hardware simple but require you to program in C or assembly language. I opted for the latter.

Two C functions are provided in the software to let you initialize the parallel port, input a 10-bit reading from the A/D board and calculate the temperature. A simple program that displays the temperature each time a key is pressed is given in Listing 1. Quick C was used for code generation.

My example software assumes that your parallel port address is LPT2. If this isn't the case, you must chage the program to reflect the correct parallel-port base address. You can determine the parallel-port base address by using DEBUG to examine word locations 40:8, 40:A and 40:C. The contents of these three words indicate, sequentially, the presence/nonpresence of LPT1, LPT2 and LPT3. A 0 indicates nonpresence. A non-0 indicates the base address of the parallel port. Standard parallel-port base addresses are hexadecimal 3BC, 378 and 278 for LPT1, LPT2 and LPT3.

The power supply you use for this project must be capable of providing 9 to 20 volts dc at a minimum of 20 mA. A plug-in dc wall module of the proper specifications will work fine. The two wires that interconnect the power supply and A/D board can be wired directly into place, or you can use a connector or terminal-block arrangement to provide easy connection and disconnection. Whatever interconnection method you opt for, though, be sure to use 26-gauge stranded wire, and make the interconnect distance no greater than 2 feet.

Construction

As I mentioned above, I've designed this project so that the temperature sensor and A/D converter are two separate subassemblies. Therefore, the circuitry is on two separate boards that can be either printed-circuit or point-to-point wired. If you wish to make your own pc boards, you can use the actual-size artwork shown in Fig. 3. Note that while the temperature-sensor board in (A) is single-sided, the A/D-converter board in (B) and (C) is double-sided. You fabricate and use the temperature-sensor board as you would any other single-sided assembly, but for the double-sided A/D-converter board, which the typical home fabricator can't plate-through, you'll have to use components and hardware that permit you access to solder all leads and pins on *both* sides of the board into place.

If you prefer to avoid fabrication

PARTS LIST

Temperature-Sensor Board

J1—Three-position pc-mount socket with pins on 0.1" centers (optional—see text)
R1—2,200-ohm, 1/4-watt, 5% tolerance carbon-film resistor
R2—10,000-ohm, vertical-mount pc-type trimmer potentiometer (Bourns No. 3299P-103 or equivalent)
U1—LM335Z temperature sensor
Misc.—Printed-circuit board; hookup wire; solder; etc.

A/D-Converter Board

C1—2.2-µF, 10-volt tantalum capacitor
C2,C3—100-pF, 10% tolerance ceramic disc capacitor
CR1—1N914 or similar switching diode
J1—Two-position pc-mount socket with pins on 0.1" centers (optional—see text)
J2—Three-position pc-mount socket with pins on 0.1" centers (optional—see text)
J3—Six-position pc-mount socket with pins on 0.1" centers
R1—27,000-ohm, 1/4-watt, 5% tolerance carbon-film resistor
R2—50,000-ohm, verrical-mount pc-type trimmer potentiometer (Bourns No. 3299P-503 or equivalent)
R3,R4—4,700-ohm, 1/4-watt, 5% tolerance carbon-film resistor
U1—LTC1092CN8 serial analog-to-digital converter
U2—LT1021CCN8-5 precision voltage reference
Misc.—Printed-circuit board; materials for making interconnect cables (see text); suitable enclosure (optional); machine hardware; hookup wire; solder; etc.

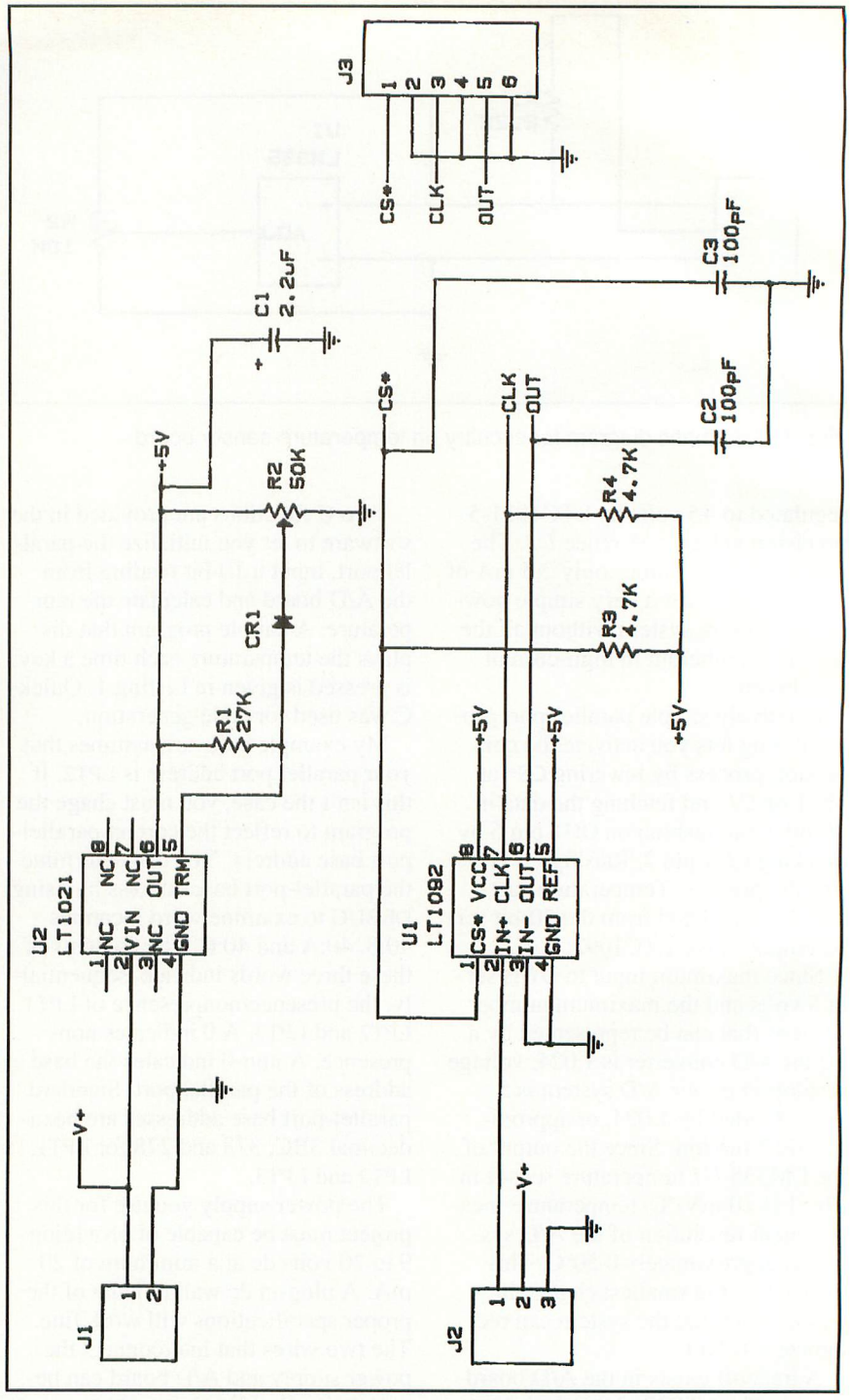


Fig. 2. Schematic diagram for circuitry on A/D-converter board.

and wiring problems with the A/D-converter assembly, you can use perforated board that has holes on 0.1" centers and suitable soldering or/and Wire Wrap hardware. Regardless of which assembly technique you use, follow the wiring guides in Fig. 4 and Fig. 5 for laying out the components on the temperature-sensor and A/D-converter boards, respectively.

Assuming you're using pc boards, begin construction by installing and soldering into place the components on the temperature-sensor board according to Fig. 4. The only caution that needs to be pointed out here is that you must properly base *U1* before you solder any of its leads into place. Note

Listing 1. Program Listing for Displaying Temperature

```
/*-------------------------------------------------------------------
--*/
/*  this program displays the temperature in degrees centigrade
/*  and will do so again each time the enter key is depressed
/*  the define contains the lpt2 base address
/*-------------------------------------------------------------------
--*/
#include <stdio.h>
#define BASEADR 888
int addat,count,indat,letter;
float degc;
main()
{
init_ad();                              /* init a to d chip  */
printf("\ntemperature display program");
tmploop:
fet_ad();                               /*  fetch a to d data  */
degc=-273+(addat/2);                    /*  calculate degrees c  */
printf("\ntemperature=%3.1f deg c",degc):   /*  display  */
letter=getchar();                       /*  await enter key pressed  */
goto tmploop;
}
/*  initialize a to d chip  */
init_ad()
{
outp(BASEADR+2,255);                    /*  set chip select inactive  */
outp(BASEADR,0);                        /*  set clock to low  */
}
/*  initiate a to d conversion by lowering chip select  */
/*  and generating one clock pulse  */
/*  gather 10 bit result of conversion MS bit first by generating 10 clock  */
/*  pulses and shifting data into temp  */
fet_ad()
{
outp(BASEADR+2,255);                    /*  set chip select line low  */
outp(BASEADR,255);                      /*  set clock line high  */
outp(BASEADR,0);                        /*  set clock line high  */
addat=0;                                /*clear temperature  */
for(count=1<=10; count ++)              /*  go thru for loop 10 times  */
{
addat=addat<<1;                         /*  left shift temperature  */
outp(BASEADR,255);                      /*  set clock line high  */
outp(BASEADR,0);                        /*  set clock line low  */
indat=!(inp(BASEADR+1))&128;            /*  invert and mask a/d data  */
if(indat==128);                         /*  shift data into addat lsb  */
addat=addat|1;
}
outp(BASEADR+2,0);                      /*  set chip select line high  */
```

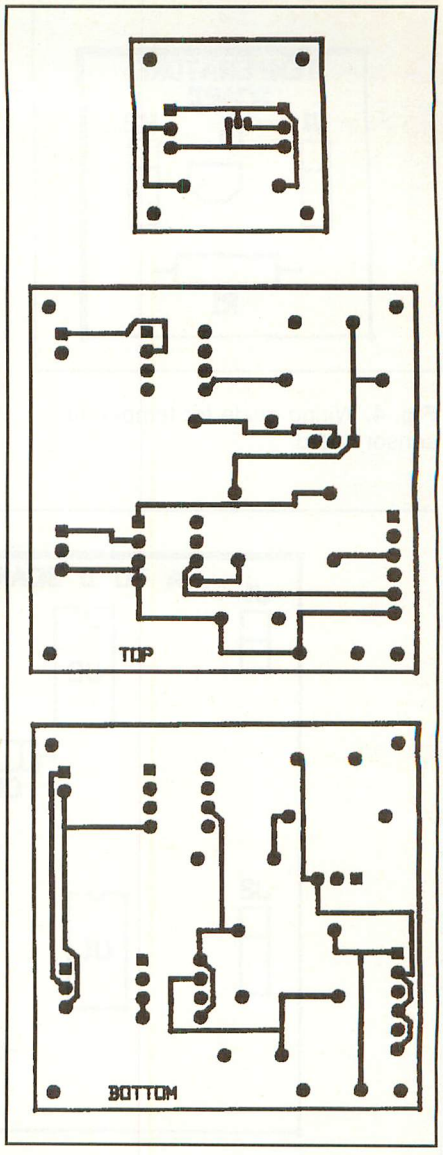


Fig. 3. Actual-size etching-and-drilling guides for (A) temperature-sensor and (B) and (C) top and bottom sides of A/D-converter printed-circuit boards.

also that connector *J1* is optional. You need it only if you wish to have a cable that you can unplug to disconnect this board from the A/D-converter board. Otherwise, eliminate *J1* and hard-wire the between-board connections. When you're finished wiring this subassembly, temperarily set it aside.

Next, referring to Fig. 5, wire the A/D-converter board. Begin by installing and soldering into place strips of Molex Soldercon pins, which provide soldering access on both sides of the board.

Once the Soldercons are in place, install the resistors, capacitors and diode into place. Before soldering their leads into place, however, make sure that electrolytic capacitor *C1* and diode *CR1* are properly oriented. Next, plug into the board connectors *J1*, *J2* and *J3* and potentiometer *R2* and solder their pins into place. As with the temperature-sensor board, *J2* is optional and is needed only if you wish to unplug the connections between the two boards. If you wish to save a few cents, you can eliminate *J2* and hard-wire the connections between the two boards.

Plug *U2* into its Soldercon-strip pair. Make sure that the IC is properly oriented and that no pins overhang the Soldercons or fold under between the IC and Soldercons. Do not plug *U1* into its Soldercon strips just yet.

The parallel-port cable requires that you solder six conductors onto the A/D converter board. When you've done this, twist together the conductors into three pairs of wires (CS*/GND, CLK/GND and OUT/GND) for soldering to a 25-pin DB-25 male connector that plugs into the female parallel-port connector on your PC. When you fabricate this cable, make sure to make it no longer than 4 feet. Figure 1 shows the connections for this cable.

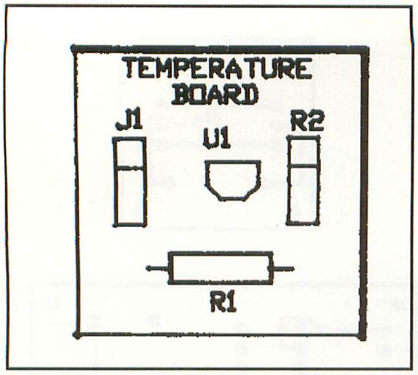


Fig. 4. Wiring guide for temperature-sensor board.

Table 1. Pinout Details of Parallel-Port Interface Cable

PC Connector Pin	Signal (Description)	Connection to A/D Converter
1	CS* (Chip Select)	J3 Pin 1
2	CLK (Clock)	J3 Pin 3
11	OUT (Output)	J3 Pin 5
18	GND (Ground)	J3 Pin 2
19	GND (Ground)	J3 Pin 4
23	GND (Ground)	J3 Pin 6

Viewing the 25-pin DB-25 connector from the rear with it oriented horizontally and with the narrower side downward, the pins in the upper row are numbered 1 through 13 from left to right and in the bottom rod from 14 through 25 from right to left.

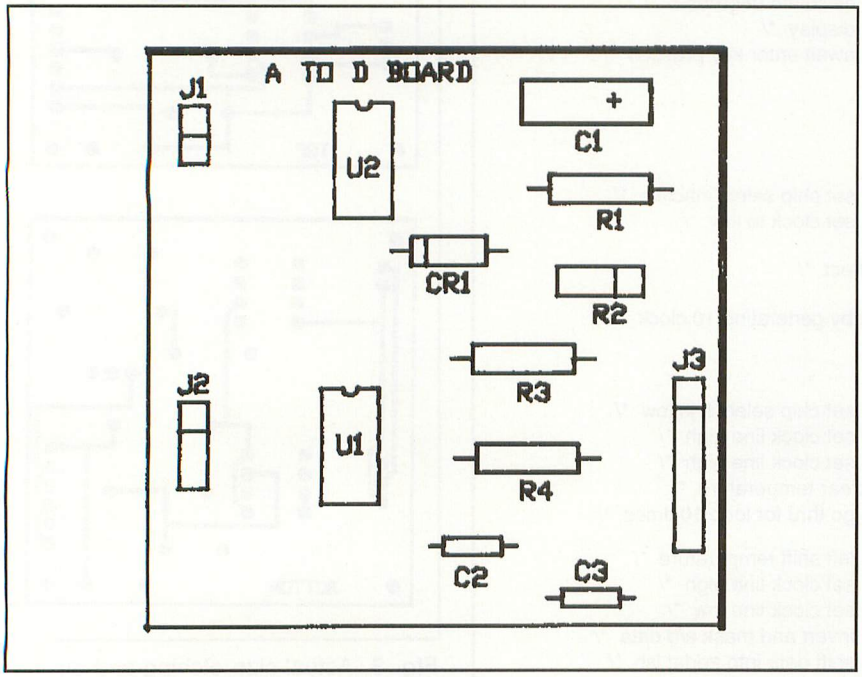


Fig. 5. Wiring guide for A/D-converter board.

As mentioned above, the three conductors that interconnect the temperature-sensor and A/D-converter boards can be hard-wired or made via *J1* on the former and *J2* on the latter boards, using mating connectors at the ends of the three-conductor cable. Again, regardless of interconnection method you choose, use 26-gauge stranded wire, and limit interconnect distance to no greater than 2 feet. Connections are pins 1, 2 and 3 to pins 1, 2 and 3, respectively.

Up and Running

Connect the power supply to the A/D-converter board with the LTC1092 not plugged into the *U1* socket and connect the leads of a dc voltmeter or a multimeter set to the dc-volts function between pin 6 of *U2* ("hot" lead) and circuit ground. Turn on the power supply and adjust trimpot *R2* until you obtain a reading as close to 5.000 volts as measurement permits at pin 6 of *U2*. Turn off the power supply and connect the A/D-converter board to the temperature sensor board. Determine the ambient temperature and turn on the power supply. Adjust trimpot *R2* on the temperature sensor board until you obtain a reading of 2.73 volts added to temperature in °C multiplied by 10 mV at pin 1 of *J1*.

Turn off the power supply and connect the A/D board to the parallel port on your computer. Plug the LTC1092 into the *U1* Soldercon strips on the A/D board and connect this board to your PC's parallel port. Turn on the power supply and run the test program. The correct temperature should be displayed.

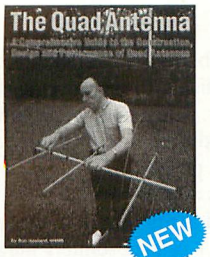
Once you've ascertained that your project is working properly, you might want to consider adding enhancements to it. For example, if you wish 0.125° C resolution, rather than the default 0.50° C resolution, you can purchase the pin equivalent 12-bit LTC1292. If you substitute this in your circuit, you'll have to slightly modify the software to fetch 12 rather than 10 serial bits.

You can also substitute your own sensor board in place of the temperature sensor board. The only requirement of the A/D board is that the maximum analog input voltage be no greater than 5 volts. Parameters to be measured that come to mind are pressure, displacement, acceleration and battery voltage.

A full line of serial A/D converters, serial D to A converters and serial EEPROMs exists. This implies that complete-data acquisition systems can be designed to work from the parallel port on a PC. Multiple analog inputs and outputs, along with digital inputs and outputs, can be accomodated by such a data-acquisition system. Serial EEPROMs give the data-acquisition unit a limited in-unit storage capability. I can easily visualize a parallel-port data-acquisition unit, for example, with eight analog inputs, eight analog outputs, 48 digital outputs, 48 digital inputs and 128 bytes of non-volatile in-unit storage. ■

CQ Books and Videos

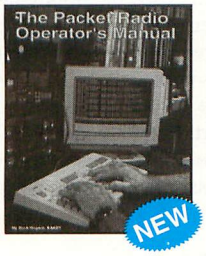
The Quad Antenna



Hams love antenna books and this book is no exception. Written by world renowned author Bob Haviland, W4MB, The Quad Antenna is the authoritative technical book on the design, construction, characteristics and applications of Quad Antennas. Discover how to easily build a quad antenna for your station that will help you fill your logbook with rare DX that you have only dreamed about before.

Order No. QUAD..... $15.95

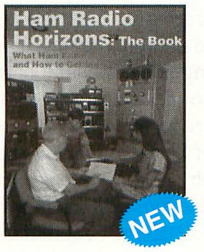
The Packet Radio Operator's Manual



This book is written by CQ columnist and Amateur Radio Packet authority Buck Rogers, K4ABT. An all new introduction and guide to packet operation, it is the perfect single source, whether you're an advanced user or just starting out. Learn about packet radio without all the technical jargon. Also included are detailed hookups for dozens of radio/packet controller/computer combinations, making this book the definitive resource for the active packet user.

Order No. PROM..... $15.95

Ham Radio Horizons: The Book



Written by Peter O'Dell, WB2D, this is a book about ham radio that every beginner can enjoy! If you want to get in on the fun and excitement of Amateur Radio, Ham Radio Horizons is the perfect way to get started. HRH is full of tips from expert hams in: DXing, Contesting, Serving the Public, Ham Radio in Space, Experimenting, Digital Communications — you name it! This exciting book is an excellent gift to a prospective ham or for use in your club's licensing classes and library.

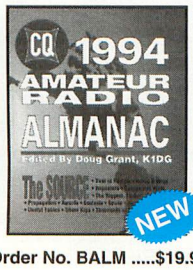
Order No. BHOR..... $12.95

The Vertical Antenna Handbook

Take advantage of the 20 years of research and practical experience of naval communications engineer Capt. Paul H. Lee, USN(ret), N6PL. Learn the basic theory, design, and practice of the vertical antenna. Discover easy construction projects such as a four-band DX vertical or a broadband array for 80 meters. Ever wonder how to build a functional directive vertical system? Paul Lee can get you started today!

Order No. VAH..... $9.95

The CQ 1994 Amateur Radio Almanac First Edition



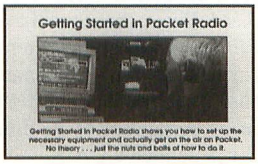
The most exciting ham radio book in years, here you have it all at your fingertips—thousands of facts and figures, maps, graphs, photos of hams and stations, a beautiful color insert, and more—in one handy volume you'll be sure to refer to over and over again. For the History. . . the Records. . .the Rules, order the Source!

Order No. BALM $19.95

Get Started with CQ's New Video Library!

Also Available In PAL format

Getting Started in Packet Radio



This video will help de-mystify the exciting but sometimes confusing world of packet radio. Learn how to get started using your computer on the radio. Included are step-by-step instructions on making packet contacts and using packet bulletin boards, networks and satellites.

Order No. VPAC.. $19.95

Getting Started in Amateur Satellites

Learn with this video how veteran operators set up their satellite stations. Find out how to locate and track ham satellites with ease. Watch as operators access current satellites and contact far ranging countries around the world. This video is filled with easy to understand advice and tips that can't be found anywhere else .

Order No. VSAT..... $19.95

Getting Started in Ham Radio

This is a fast-paced video introduction to the fascinating world of ham radio. CQ's experts show how to select equipment and antennas; which bands to use; how to use repeater stations for improved VHF coverage; the importance of grounding and the basics of soldering. How to get the most out of your station, whether it's home-based, mobile or hand-held.

Order No. VHR $19.95

Getting Started in DXing

Top DXers share their experience with equipment, antennas, operating skills, and QSLing. You'll see hams work rare DX around the world. If you're new to DXing, this video is for you! All this valuable information may well give you the competitive edge you need to master the exciting world of DXing.

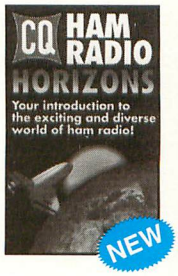
Order No. VDX..... $19.95

Getting Started in Contesting

For the newcomer to contesting or an experienced veteran, this video is for you! You'll get advice and operating tips from some of contesting's most successful competitors, including Ken Wolff, K1EA, Dick Newell, AK1A, and CQ's own contest columnist, John Dorr, K1AR. Here's just a sample of what you'll see: what contesting's all about, explaining contest jargon, tips for beginners, how to compete from a small station, operating secrets from the "pros", live QSOs from world class stations, VHF/UHF contesting

Order No. VCON $19.95

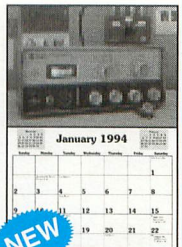
Ham Radio Horizons: The Video



This introduction to Amateur Radio is an excellent complement to the Ham Radio Horizons book. Enjoy seeing all aspects of ham radio ranging from what it takes (and costs) to get started to how you can get your ham license. Designed for the general public, HRH is ideal for public events, presentations to community groups and as an opening to your club's licensing courses! There's no better way to introduce someone to ham radio.

Order No. VHOR.....$19.95

1994 Radio Classics Calendar



Imagine ham radio history being displayed on your wall with CQ's new **1994 Radio Classics Calendar.**

If you enjoy nostalgia, you'll want CQ's **1994 Radio Classics Calendar.** Each month you'll reminisce about radio history with striking photography of rare morse keys, antique radios and radio tubes.

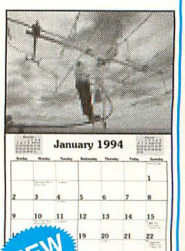
And there's more . . .

You'll refer to your **1994 Radio Classics Calendar** time after time as you search for the schedules of upcoming ham events and conventions. Public holidays and useful astronomical data will be at right by your side, too!

Receive 15 months of use (Jan '94 - Mar '95) with custom photography that has never been published anywhere else. And all at the low price of only $9.95 each. CQ's **1994 Radio Classics Calendar**—a great product for every nostaligia buff.

Order No. CCAL.....$9.95

1994 Amateur Radio Calendar



There's no better addition to your shack or office than CQ's new **1994 Amateur Radio Calendar.**

If your interest is towering antennas with stunning scenery and shacks that go beyond belief, then the **1994 Amateur Radio Calendar** is for you. Envision seeing professional photographs of some of the biggest stations in the world!

CQ's **1994 Amateur Radio Calendar** contains dates for major operating events and conventions. In addition, it's chock-filled with public holiday and commemorative dates plus valuable astronomical information.

With CQ's **1994 Amateur Radio Calendar**, you actually receive 15 months of use (Jan '94 - Mar '95)—and with all-new photography that can't be beat! At only $9.95 each, this is a real bargain from CQ.

Order No. HRCAL.....$9.95

For Fastest Service, Order Toll Free 1-800-853-9797

Or FAX 516-681-2926 Also available at your local dealer!

Software Review **By Craig S. Stevenson**

SpinRite 3.1 Tackles Hard-Disk Disasters

It doesn't matter if you have an MFM, RLL, IDE, ESDI or SCSI hard drive, the bottom line is that there are only two types of hard drives: those that have failed and those that *will* fail. I was abruptly reminded of this awhile back when one of my customers had his fairly new 213M hard drive fail un-expectedly. The computer wasn't even being used at the time of the failure. *Windows* 3.1 generated a UAE (Unrecoverable Application Error) with the screen blanker operating but with no applications open.

When I arrived at the customer's site, I ran a quick CHKDSK to determine if any problems existed. CHKDSK reported that everything was okay. However, when I re-booted the machine, the hard drive made strange noises when attempting to load DOS. Eventually, the machine booted. However, knowing that there was something seriously wrong, I ran a hard-disk utility to check for bad sectors on the drive. There were bad sectors all over the place! Even though many programs would still run, the drive was failing, right before my eyes. I quickly copied as many data files as I could to floppy diskettes and printed out all the business reports that I could from the programs that still operated correctly. Luckily, my customer hadn't done a great deal of work on the machine yet, and I was able to recover most of his data.

This experience made me realize that in spite of all of the technological advances that have been made with regard to hard drives, I'd been taking their reliability for granted. It was only a month prior to this incident that another customer had a single sector go bad on an 80M hard drive, requiring restoration of month-old data files from a tape backup. If these two incidents had been spread out over several months, I probably wouldn't have given it much thought to them. However, when problems of this magnitude occur within 30 days of each other, this gets my attention.

Another problem that I encountered was that my existing hard-disk utilities were inadequate to work on these drives. Since both of these were IDE drives, my normal hard-disk surface analysis utilities wouldn't work properly.

Several days after the last of these incidents, *SpinRite* 3.1 arrived at my office. Right up front, I'll state that *SpinRite* 3.1 is an absolutely magnificent piece of software, providing comprehensive hard-drive identification, benchmarking, testing and data recovery. Many of these capabilities can also be used on floppy drives. I recently used the floppy-drive-recovery capability when a software package arrived at my office with three compressed programs on one disk. Two programs copied to the hard drive, but attempting to copy the third resulted in a "Data error reading drive A:. Abort, Retry, Ignore, Fail?" error message. *SpinRite* 3.1 was able to repair the bad sector, and the file was successfully copied to the hard drive.

IDE Drives

Although *SpinRite* is compatible with the vast majority of hard drives—including MFM, RLL, ESDI, SCSI, and IDE—support for IDE drives is essential in today's computer industry. IDE drives integrate the controller card onto the drives themselves, which helps to reduce complexity and manufacturing costs while increasing reliability and performance. Many IDE drives also incorporate sector translation, which allows these drives to appear to have a different combination of heads, cylinders (tracks) and sectors than the true physical drive parameters. This makes it possible to use these drives in a variety of systems, even if the BIOS doesn't contain the exact drive parameters. This technique circumvents the BIOS limit that prevents use of drives with greater than 1,024 cylinders without a software device driver or a controller card that can perform sector translation.

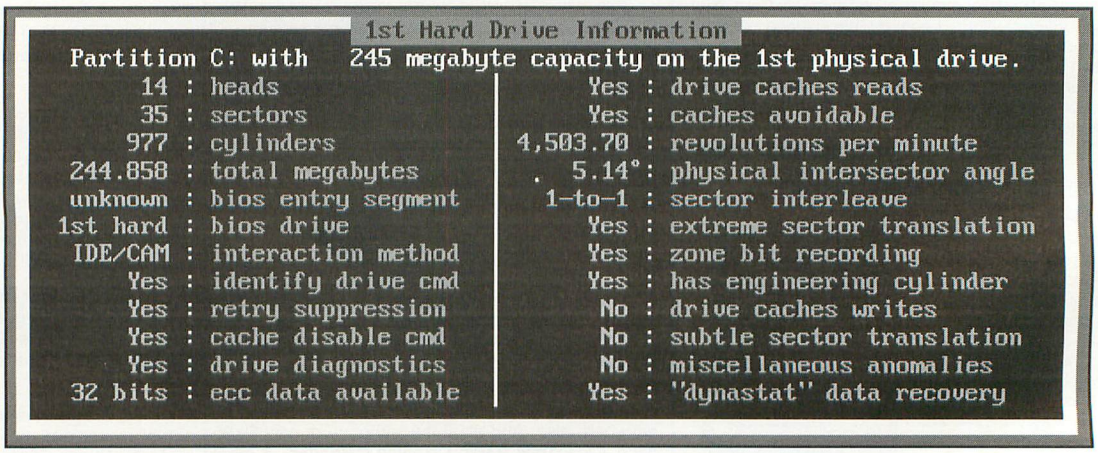


Fig. 1. This screen capture of a portion of the hard-drive information *SpinRite* 3.1 is able to obtain from a Seagate ST-3283A IDE drive.

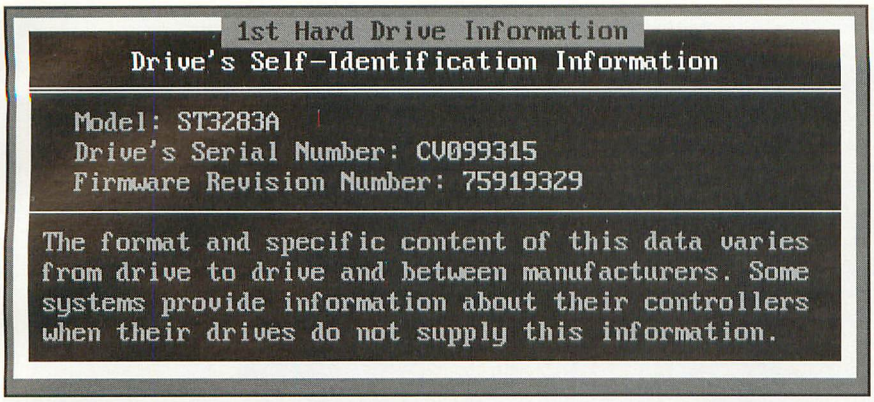


Fig. 2. *SpinRite* culled this information from the Seagate ST-3283A drive and displayed it on its self-identification screen.

Table 1. Benchmark Results for Seagate ST-3283 Hard Drive

Parameter	Result
Random Sector Access	19.773 milliseconds
Sector Access Velocity	3,492M bytes/second
Burst Transfer Rate	1,982,410 bytes/second
Sustained Transfer Rate	1,408,808 bytes/second

The downside of this approach is that the true physical parameters of the drive are hidden, making it more difficult for disk utility software to work properly with these drives. *SpinRite* overcomes these problems and works well with most, if not all, IDE drives.

SpinRite 3.1 contains many features new to this version, including direct hardware-level interaction with hard disk controllers and compatibility with partition compression software. The program now interfaces directly to the hard-disk system's hardware, rather than through the BIOS. This improves *SpinRite*'s sensitivity when detecting media defects, since *SpinRite* is able to determine the location of a surface defect after a single error, rather than requiring multiple occurrences. This should enable detection of marginal sectors before they become so bad that data can't be recovered. Support for partition-compression products like *DoubleSpace* 1.0 and later, *SuperStor* 1.3 and later and *Stacker* 2.0 and later has also been added to *SpinRite* 3.1. Since more data is packed into each sector when using these products, it's imperative that the drive surface be tested thoroughly to ensure its integrity.

I generated the screen-captures used in this report with *SpinRite* 3.1 in actual operation on a Seagate ST-3283A IDE drive. To capture these screens, I loaded a screen-capture utility prior to executing *SpinRite*. Doing this is definitely *not* a good idea. In fact, there are many warnings against loading *any* kind of TSRs when using *SpinRite* in the manual that accompanies the program.

During the course of capturing these screens, *SpinRite* detected an error in one of the sectors on the drive. (I have no doubt that this problem was caused by having the screen-capture utility loaded and interrupting *SpinRite*'s operation to capture the screens I needed.) *SpinRite* moved the data from the faulty cluster, relocated it to a safe area and marked the offending cluster as bad. After re-booting with a "clean" system, as recommended, *SpinRite* re-tested this cluster, determined that there was nothing wrong and reclaimed it for use. Although any data loss in this case would have clearly been my fault, it's still encouraging to see how bulletproof *SpinRite* really is.

Prior to beginning any disk tests, *SpinRite* performs an integrity check on itself to test for viral infections and then checks system RAM, floppy-disk controller and hard-disk controller. An "Interrupt System Noise Test" is also performed, which measures the background-noise level of the interrupt system. Maximum and minimum noise levels are shown, along with the difference between the two.

This particular test caught my attention because it helps to explain a problem that I've noticed on one of my computers. I have an older 386DX-25 computer that's fussy about which video card is installed in it. Some video cards will display fuzzy-looking characters when installed in this computer. But when the same cards are installed in another computer, the characters look fine. My Sound Blaster sound card also acts strangely when installed in this machine, producing all sorts of weird background noises. If the card is moved to another computer, it's dead quiet.

While reviewing the background material for this report, I decided to compare the interrupt system noise test results from another system to those from this particular 386DX-25 computer. The reference system for this article, a 386DX-40 showed a maximum noise level of 75 and a minimum level of 33. The troublesome 386DX-25 system exhibited maximum/minimum noise levels of 127/45. Clearly, the interrupt system on this machine is much noisier than on the reference system, possibly explaining what's causing these strange problems. It's interesting that a "hard-drive utility" can provide insights into other problems that aren't directly related to the hard drive.

Hard-Drive Information

Figure 1 shows a portion of the hard-drive information that *SpinRite* 3.1 is able to obtain from a Seagate ST-3283A IDE hard drive. Much of this information doesn't appear in the sparse hard drive installation guide provided by Seagate. For example, I was surprised to learn that this drive had a rotational speed of 4,500 rpm. I verified the accuracy of this figure with some detailed Seagate technical documents that I have, and it's on the money. I also verified that the drive caches reads but not writes, as shown.

Additional information is contained in the drive self-identification screen shown in Fig. 2. The first time I used *SpinRite* 3.1 and accessed this screen, I was astounded to see the model, serial and even firmware (ROM) revision number of the drive, without ever taking the cover off my computer's system unit.

SpinRite also calculates hard-drive performance benchmarks, which include random sector access, sector access velocity, burst transfer rate and sustained transfer rate. These benchmarks are designed to more closely reflect how fast the drive "feels" during actual operation. My experience tends to support this contention. The Seagate ST-3283A "feels" fast in its 386DX-40 host system, and the benchmarks reflect it, as shown in Table 1.

Testing Levels

Before the actual testing of the drive begins, you are asked to select a level of operation for *SpinRite*. These levels are:

Level 1	Examine the Surfaces
Level 2	Recover Unreadable Data
Level 3	Refresh the Surfaces
Level 4	Light Defect Analysis
Level 5	Moderate Defect Analysis
Level 6	Deep Defect Analysis
Level 7	Restore Good Sectors

Level 1 Examine the Surfaces simply attempts to read from each sector on the drive. It's a quick read-only test that sim-

ply reports any errors found, but it doesn't perform any surface analysis or recover data that might be in jeopardy.

Level 2 Recover Unreadable Data adds data recovery to level 1. Unreadable areas of the drive are processed using DynaStat Data Recovery in an attempt to recover the data. Then the area under the data is subjected to *SpinRite*'s most thorough level of surface testing. If a defect is located, the area is marked as bad, and the data is relocated to a safety zone. This is the level I use when attempting to recover data on floppy disks and when I want a quick check of a hard drive.

Level 3 Refresh the Surfaces adds a complete read and write operation to Level 2. Each sector of the drive is read and re- written to refresh and realign the data under the drive's read/write heads. This level is particularly useful for older stepper-motor drives whose alignment drifts with time.

Level 4 Light Defect Analysis adds surface testing to the previous levels. This surface testing isn't as comprehensive as the testing used in higher levels, but it's noticeably faster.

Level 5 Moderate Defect Analysis performs surface testing that's three times more rigorous than under Level 4 testing. This level provides a good compromise between speed and thoroughness.

Level 6 Deep Defect Analysis is *SpinRite*'s most rigorous surface-testing level and should be used the first time you run *SpinRite* to provide assurance that the drive's surfaces are in perfect condition.

Level 7 Restore Good Sectors performs the same functions as in Level 6, but it will also return to use sectors that had previously been marked bad if they pass *SpinRite*'s surface analysis. Use this testing level with caution! My opinion always has been and always will be that if the drive manufacturer tested the drive and determined that certain areas of the disk surfaces are bad, they should remain bad. Period! Previous versions of *SpinRite* defaulted to returning sectors to use if they tested good, creating problems on some drives on which the ability to read marginal sectors changed as their temperature fluctuated. The approach in *SpinRite* 3.1 is a welcome change. The option still exists to recover these areas, but *SpinRite* doesn't default to using this setting. (I used Level 7 to recover the sector that *SpinRite* had marked bad when performing these screen captures because I was fairly certain that I'd caused the problem in the first place by loading in the screen-capture utility in contradiction to the warnings I'd read.)

Another nice touch is that you can change the operating level on-the-fly. For example, I generally test the first part of

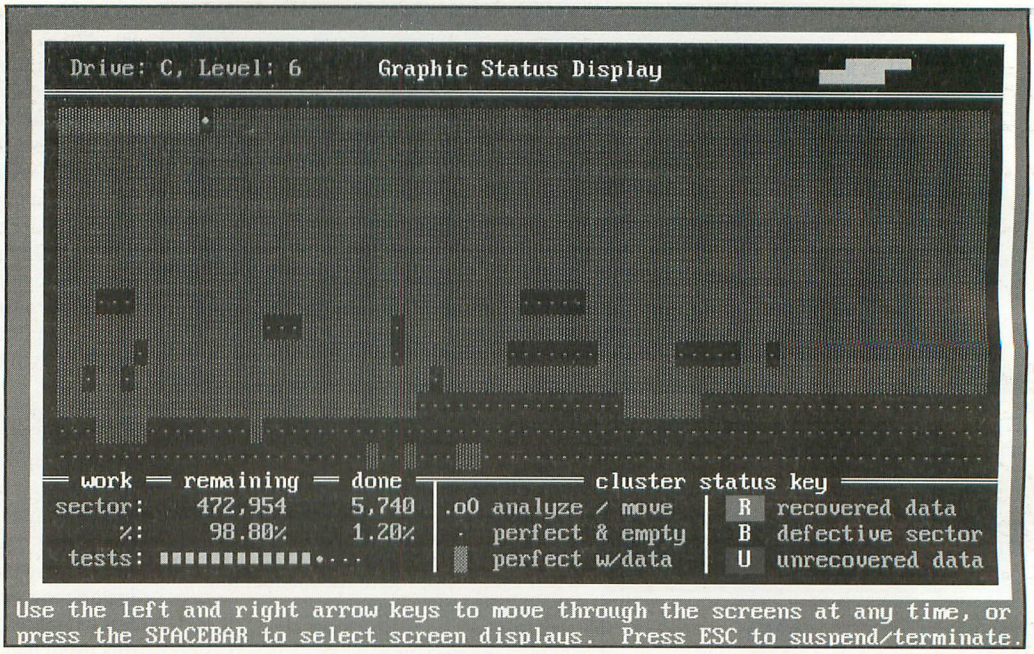


Fig. 3. The program's Graphic Status Display screen contains an overview of the arangement and condition of the sectors on the hard drive being tested.

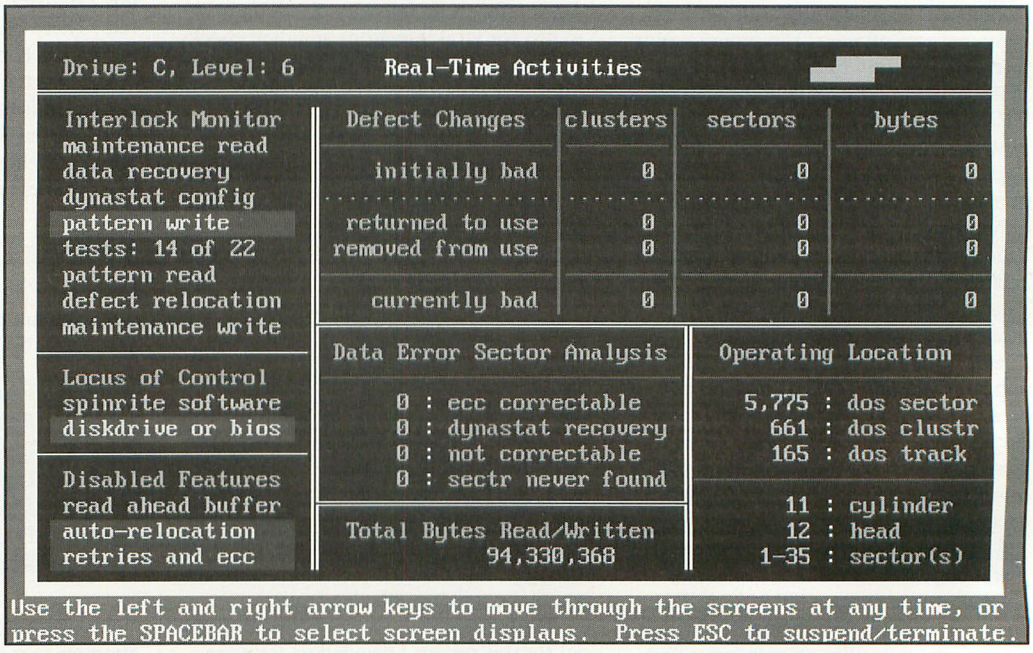


Fig. 4. A more-detailed analysis of *SpinRite*'s operation is displayed on the Real-Time Activities screen.

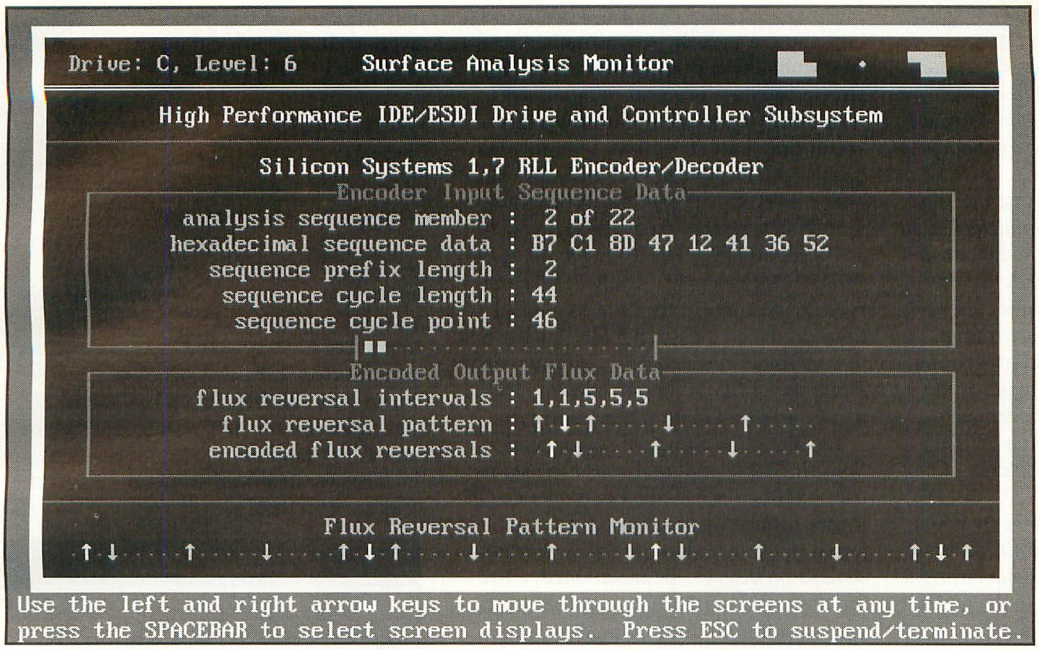
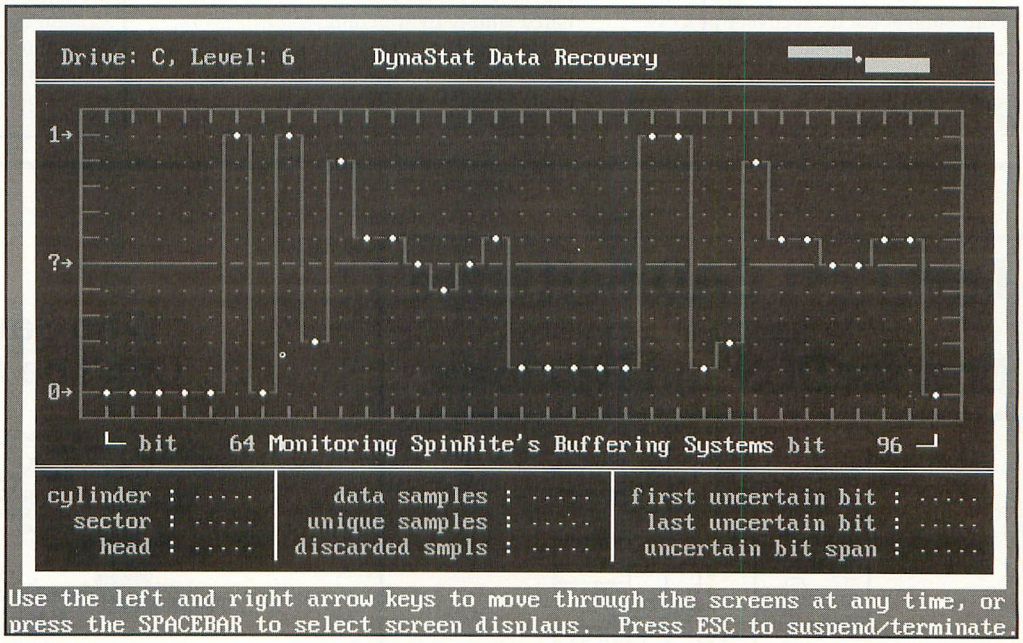


Fig. 5. The Surface Analysis Monitor gives detailed information about the surface-analysis process. It's displayed when an operating level that involves surface testing is selected.

Fig. 6. In DynaStat Data Recovery, *SpinRite* attempts to reconstruct the damaged data using a system of statistical analysis. The figures at the bottom of the screen are updated to inform you on the recovery process.

the drive—which contains the boot sector, file allocation tables and important DOS files—at Level 6. After these critical areas have been thoroughly tested, I reduce the testing level to speed up the process. If a drive appears to have problems, I go back and re-test it more thoroughly.



Features & Capabilities

Figure 3 shows the Graphic Status Display screen, which contains an overview of the arrangement and condition of the sectors on the hard drive being tested. Users of previous versions of *SpinRite* will find this screen familiar, as it's similar to the screen used in earlier versions of the program.

A more detailed analysis of *SpinRite*'s operation is displayed on the Real-Time Activities screen, as shown in Fig. 4. This screen is a constant flurry of activity during operation and summarizes *SpinRite*'s findings and activities since the current operation was started.

A detailed technical log is generated by *SpinRite* during its operation, which can be written to a file or other device. This log contains information regarding *SpinRite*'s findings and operation and can also be viewed while the program is running.

SpinRite 3.1 boasts significant improvements in its ability to detect surface defects by using a variety of new technologies. The Surface Analysis Monitor, shown in Fig. 5, gives detailed information about the surface-analysis process and is displayed when an operating level has been chosen that involves surface testing. Rather than attempting to explain this extremely technical process in my own words, I offer the following quote from the *SpinRite* 3.1 Owner's Guide:

SpinRite's surface analysis system delivers a breakthrough in software-based magnetic storage media certification.

By recognizing the manufacturer of a drive, or the drive and controller's recording technology, SpinRite utilizes its knowledge of the relationship between the input data and the resulting magnetic flux reversal output for each individual drive, to design a series of data sequences which act to deliberately reduce the "gain" of the drive's read-amplifier while subjecting the drive to a "weakest possible" magnetic flux reversal series.

By working backwards from a set of "spatially phased" goal flux-reversal sequences (shown at the bottom of the Surface Analysis Screen), SpinRite designs custom testing data for each drive. This allows SpinRite to quickly place one of these "weakest possible" flux reversals at every "bit-cell" location across the drive's

surface while continuing to minimize the drive's gain.

If there's anything whatsoever weak or uncertain about any spot on the drive, SpinRite's surface analysis technology will detect it and prevent its use in the future.

It should be obvious to anyone reading this quote that the author of *SpinRite* has an intimate understanding of the magnetic and electrical properties of hard-disk drives. This becomes even more apparent after using the software for a very short time.

Finding surface defects and preventing their use in the future, is only part of the job, however. When a sector becomes unreadable, it's important that a valiant attempt be made to recover the data, if at all possible.

Figure 6 shows the program's DynaStat Data Recovery screen. Here, *SpinRite* attempts to reconstruct damaged data using a system of statistical analysis. In the midst of actual data recovery, the figures at the bottom of the screen are updated to show information about the recovery process. During the floppy-diskette recovery process that I referred to earlier, DynaStat was employed to completely recover the damaged data, restoring the file to perfection.

Since the file recovered was a compressed one, any errors in the reconstruction process would have been reported as a CRC error when the file was decompressed.

SpinRite 3.1 is one of few programs you'll find written in 100% assembly language—1,315,024 bytes of assembly language, to be exact. The lure of programs written in assembly language is that they are small and fast. The .EXE file for *SpinRite* 3.1, for example, is only 75K! Compare this to some of the bloated applications produced today, and you'll agree that there's something decidedly different about *SpinRite* 3.1. It also has an elegant "feel" that I don't find in most other software.

In spite of its technical sophistication, *SpinRite* 3.1 is extremely easy to use. Its user interface is excellent and operates in a very refined manner. *SpinRite*'s own internal multi-threaded capability permits several process to operate at once, allowing the various information screens to be viewed without interrupting those other processes. I must confess to being fascinated simply by watching *SpinRite* work.

Designed for novice and expert alike, a complete hypertext help system is also included, which details known incompatibilities, answers commonly asked questions, defines many of the specifications and features that *SpinRite* reports, and contains a wealth of other technical information.

Prevention

The best cure for data loss is prevention. Remember, the question isn't will data loss occur? but, rather, when. No matter how good the hardware is and how careful you are, data loss can still occur at any time. Protect yourself and your data. *SpinRite* 3.1 should be an integral part of any arsenal of high-powered tools you use to recover from hard-disk disasters. Combined with reliable and up-to-date backups, *SpinRite* can help ensure that the potential for data loss is minimal and the chances for data recovery in the event of a loss are excellent. ■

Product Tested

SpinRite 3.1, $89 + $4 S&H
Gibson Research Co.
35 Journey
Aliso Viejo, CA 92656
Tel.: 714-362-8800

CIRCLE NO. 160 ON FREE INFORMATION CARD

Microcomputer Q&A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronic queries. Since I draw from a large source of knowledgeable contributors, feel free to ask whatever questions you may have regarding computing on the platform. Address your queries to me care of *MicroComputer Journal*, 76 North Broadway, Hicksville, NY 11801.

Same-Performance 386-to-486 Upgrade

Q: *Having recently replaced my 40-MHz 386 motherboard with a 33-MHz 486 unit, I don't notice any improvement. How come? Do I have a lemon?*
A: No, the 40-MHz 386 AMD chip is pretty fast and on par with the 486 for several applications—specifically DOS-based word processors and spreadsheets. You didn't make a bad move. You just to need to upgrade your software, too. Where you'll notice the most improvement is in graphics applications, such as *CorelDRAW* and *AutoCAD*.

DoubleSpace and Hard-Disk Space

Q: *I use MS-SOS 6.0 DoubleSpace and it tells me I have 20M of free hard-disk space. But, try as I might, I can't copy the contents of my* Windows for Workgroups *files to the disk. It says I don't have enough room. What's wrong?*
A: Absolutely nothing is wrong. Because DoubleSpace compresses the data, 20M is an *estimate* of available disk space—*after* the data is compressed. In reality, you have about 10M. Like many programs, *Windows for Workgroups* files are already compressed on the floppy distribution disks and total 12M. Consequently, they won't fit. DoubleSpace can't compress a compressed file.

Eliminating (Some) Hard-Disk Crashes When Using MS-DOS 6.0's DoubleSpace

Q: *I installed DoubleSpace on my PC with a CD-ROM drive, and now I'm having problems with hard-disk crashes and data loss. Can you help?*
A: It probably has to do with the CD-ROM's drive-letter designation. DoubleSpace takes up residence exactly four drive letters past the last drive used. So if your CD-ROM is using the letters W: through Z:, DoubleSpace is wrapping around to the beginning of the alphabet—which is causing the problem. The cure is to change the CD-ROM drive designation to an unused letter earlier in the alphabet.

XMS and EMS Explained

Q: *What's the difference between XMS and EMS memory? Why do some programs need one and others the other? I'm confused.*
A: Both refer to memory beyond 640K, and both need special software drivers to work. XMS stands for extended *memory* that exists beyond 1M and is accessed using the HIMEM.SYS driver found in DOS. *Windows* is an example of a program that uses XMS memory. Before HIMEM.SYS, a consortium of vendors, which included Intel and Microsoft, devised a scheme called *expanded* memory—EMS—that accesses upper memory in 64K gulps via shadow RAM, which is a small gap of memory between the video controller and BIOS. Programs *AutoCAD* and Lotus *1-2-3* use it. QuarterDeck's *QEMM386* program is the most-popular EMS driver. Unfortunately, the two aren't interchangeable. If your software calls for XMS memory, you have to provide it using the drivers found in DOS or third-party software; EMS memory won't work.

Storing Computer Equipment

Q: *Is it okay to store my PC and monitor in an unheated facility in which temperatures range from 8° to 40° F? I need to store the equipment for six weeks.*
A: Sure it's okay. Most vendors guarantee a storage range of 14° to 140° F. Therefore, an occasional dip to 8° F won't hurt. Just make sure you give the units plenty of time (about 24 hours) to warm up to room temperature before powering them up again. If you don't, condensation can form and short out the electronics.

Exceeding the Maximum

Q: *When I recently tried to install a new* Windows *application, to my bewilderment, the installation program said I was out of memory and that I had to delete a group to proceed. Which I reluctantly did. Is there any way to increase the number of* Windows *groups?*
A: The maximum number of *Windows* groups—or Program Manager icons—is purposely limited to 40 to protect your *Windows* resources. Actually, I'm kind of surprised that you're able to keep track of that many icons. But the answer is to consolidate them. Instead of having one group for *CorelDRAW* and another for *HiJaak*, for example, put them together under a single umbrella called "Drawing" or something similar. Simply create the master group, then drag and drop the program icons from the application groups to your new group. Finally, delete the empty application icon. It also helps to delete READ.ME files. I have about 100 applications in my *Windows* nestled in 10 groups.

DOS 6.x's SmartDrive and Lost Files

Q: *I'm having a big problem with data loss. At the end of the day, I save my files and then turn off my system. When I come in the next morning, my saved files aren't there. What's happening?*
A: The gremlin is SmartDrive, which, by default,

has delayed write-back. What's happening is that you're saving your data to RAM, not your hard disk. Generally, SmartDrive waits about 5 seconds before it actually writes the data to your hard disk. With you turning off your system right after saving your files, the data is lost before it's loaded onto the hard disk. There are two solutions: count to 10 before turning off your PC or disable the write-back feature by modifying your SmartDrive line to include a minus sign for the drive. For example: C:\DOS\ SMARTDRV -C 1024

The Font is the Culprit

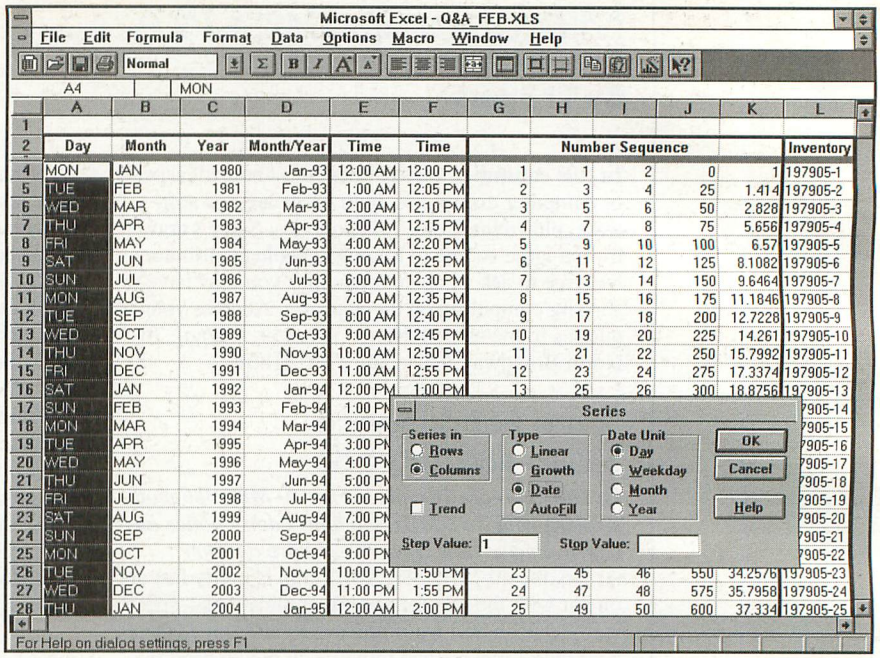
Q: *I recently installed Delrina's* WinFax Pro *and I'm less than satisfied. When I try to run character recognition, it doesn't translate even half the document. Most of it is gibberish and contains strange characters. Can this be fixed?*

A: Unfortunately, this happens a lot with OCR (optical-character-recognition) software. It's not exclusive to *WinFax*. Unless the font is easily recognized, you're going to get garbage. Courier is the easiest font to recognize, followed by Elite. Some of the fancier and kerned (proportionally-spaced) fonts fail miserably.

Let *Excel* Create The Needed Series

Q. *I do a lot of* Excel *spreadsheet work for inventory control and find myself spending a lot of time entering long columns of part numbers that differ by only one number. Is there a faster way?*

A. There is. You can use the Series option under the Data menu to have *Excel* do the counting for you. For example, if your part-number sequence is 179705-1, 179705-2, etc., *Excel* will automatically assign the next cell a value of 197905-3, and so on. If you're using *Excel* 4.0, you don't even have to pull down the Data menu. Simply enter a couple values that represent the sequence, highlight the sequence, click on the small square located in the lower-right corner of the bottom cell and drag. When you release the mouse button, the sequence is automatically entered in the range specified. Series sequences can also be expanded by the row. Furthermore, series entries aren't limited to just numbers. You can also use them for days, months, years and time, as in the screen capture shown above.



	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Day	Month	Year	Month/Year	Time	Time	Number Sequence					Inventory
4	MON	JAN	1980	Jan-93	12:00 AM	12:00 PM	1	1	2	0	1	197905-1
5	TUE	FEB	1981	Feb-93	1:00 AM	12:05 PM	2	3	4	25	1.414	197905-2
6	WED	MAR	1982	Mar-93	2:00 AM	12:10 PM	3	5	6	50	2.828	197905-3
7	THU	APR	1983	Apr-93	3:00 AM	12:15 PM	4	7	8	75	5.656	197905-4
8	FRI	MAY	1984	May-93	4:00 AM	12:20 PM	5	9	10	100	6.57	197905-5
9	SAT	JUN	1985	Jun-93	5:00 AM	12:25 PM	6	11	12	125	8.1082	197905-6
10	SUN	JUL	1986	Jul-93	6:00 AM	12:30 PM	7	13	14	150	9.6464	197905-7
11	MON	AUG	1987	Aug-93	7:00 AM	12:35 PM	8	15	16	175	11.1846	197905-8
12	TUE	SEP	1988	Sep-93	8:00 AM	12:40 PM	9	17	18	200	12.7228	197905-9
13	WED	OCT	1989	Oct-93	9:00 AM	12:45 PM	10	19	20	225	14.261	197905-10
14	THU	NOV	1990	Nov-93	10:00 AM	12:50 PM	11	21	22	250	15.7992	197905-11
15	FRI	DEC	1991	Dec-93	11:00 AM	12:55 PM	12	23	24	275	17.3374	197905-12
16	SAT	JAN	1992	Jan-94	12:00 PM	1:00 PM	13	25	26	300	18.8756	197905-13
17	SUN	FEB	1993	Feb-94	1:00 PM							?905-14
18	MON	MAR	1994	Mar-94	2:00 PM							?905-15
19	TUE	APR	1995	Apr-94	3:00 PM							?905-16
20	WED	MAY	1996	May-94	4:00 PM							?905-17
21	THU	JUN	1997	Jun-94	5:00 PM							?905-18
22	FRI	JUL	1998	Jul-94	6:00 PM							?905-19
23	SAT	AUG	1999	Aug-94	7:00 PM							?905-20
24	SUN	SEP	2000	Sep-94	8:00 PM							?905-21
25	MON	OCT	2001	Oct-94	9:00 PM							?905-22
26	TUE	NOV	2002	Nov-94	10:00 PM	1:50 PM	23	45	46	550	34.2576	197905-23
27	WED	DEC	2003	Dec-94	11:00 PM	1:55 PM	24	47	48	575	35.7958	197905-24
28	THU	JAN	2004	Jan-95	12:00 AM	2:00 PM	25	49	50	600	37.334	197905-25

Clock Still Runs Slow

Q. *The clock in my PC runs slow, losing about a minute a day. I've done everything I can think of, including replacing the battery and measuring the crystal frequency using a digital counter, to correct this. Even so, it continues to run slow. What am I overlooking?*

A. It's recently come to light that the HIMEM.SYS utility can cause the clock to run slow in some systems. DOS 6.0 has a switch that *may* correct the problem. If your computer's clock changes when you install HIMEM, change your CONFIG.SYS line to read:

```
DEVICE=C:\DOS\HIMEM.SYS /CPUCLOCK:ON
```

However, doing this doesn't work with all systems, and enabling the option slows down HIMEM.

Super-VGA Upgrades

Q. *I have a Packard Bell 386SX that came with VGA built in. I'm now in the market for super-VGA. How do I upgrade?*

A. It depends on how old your Packard Bell PC is. Most use a video chip from Oak Technologies; a few have video chips from Western Digital (Paradise). Chances are good that the chip already supports super-VGA. All you need are the super-VGA drivers that should have come with the PC on a utility disk. If you don't have the disk or it doesn't provide the resolution you're looking for, you'll have to plug a video card into one of your free expansion slots. Before you do, though, you have to disable the built-in VGA. Generally this is done by setting a jumper or DIP switch. Check your owner's manual for specifics. Some PCs, such as those from AST and ALR, can sense when a super-VGA card has been added and automatically disable the built-in video.

Disable Call Waiting

Q. *I have call waiting, which is great for a phone as busy as mine. But if I'm using my modem and the call-waiting feature clicks in, I lose my modem connection and have to start all over. This is most irritating, especially when I'm on a bulletin board. Short of canceling the service, is there a way to temporarily disable the call-waiting feature while the modem is on line?*

A. Yes, it's very easy to disable call waiting for the duration of a modem call. If you have AT&T, dial *70 first and wait for a second dial tone before dialing your number. The code can be added to your modem's Hayes command string using the following line:

```
ATDT *70,,,<<number to be dialed>>
```

If you're a GT&E customer, the disable code is 70#. For other carriers, check with your local business office. Call waiting is automatically re-enabled when you hang up the phone.

Windows Sound Without A Sound Card

Q. *I heard that there's a* Windows *program that lets one pipe sound from a CD-ROM and other multimedia devices to a PC's speaker, thus avoiding the cost and hassle of a sound card. Do you know anything about it?*

(Continued on page 110)

Ted Needleman

Microcomputer Musings

Image Capture and the Big Picture

I love playing with computer video, but the more I use it, the more I wonder if it really is worth all the hoopla. I look at some of the beautiful full-motion stuff at COMDEX and PC Expo and then go home to try duplicating it. With thousands of dollars of review equipment and hundreds of megabytes of review software, I haven't come close to producing anything even approaching the professional quality I've been seeing at the shows!

Now, admittedly, a large part of this failure is probably attributable to the basic fact that though I'm wildly enthusiastic about digital video, I'm not correspondingly talented in this area. At the same time, I keep on hoping that the level of the technology has reached the point where the hardware and software can compensate for my being graphically disadvantaged. After all, draw packages like *Windows DRAW!*, *Jurassic Art* and *VISIO* enable me to generate something other than unrecognizable blobs. Unfortunately, while things keep on improving, my film debut still seems to be a ways off. With this caveat mentioned, on with the reviews.

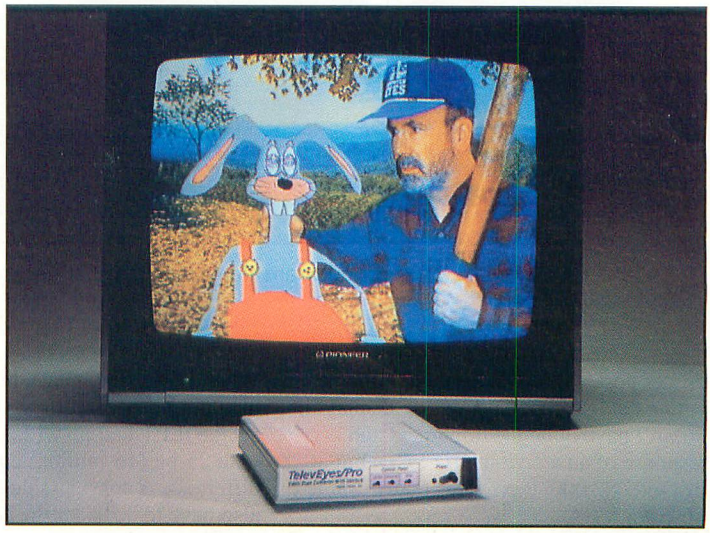
Grab That Image

One area where I do manage to use video moderately effectively is in desktop publishing. Depending on the specific project, I may scan in a picture or photograph on a flatbed scanner, use a frame grabber with my Minolta 8-mm camcorder or use a digital camera. I've used a fair number of frame grabbers over the years. One of the first, almost a decade ago, was a slow-scan unit from a new (at that time) company called Digital Vision. Over the years, this company has improved on its products and even done a bundling deal with Canon on its ZapShot digital camera. For the past couple of years, Digital Vision's ComputerEyes/RT has pretty much stayed in my main PC, ready to perform image capture on demand.

Recently, I received an interesting new unit from Digital Vision. One major problem with frame grabbers is that you need to open up your PC to install them in a slot on the expansion bus. If you're among the terminally klutzy, out of open slots or want to use a notebook or other PC that doesn't offer an ISA or EISA bus, you're probably out of luck (though there are a number of frame grabbers that work with IBM's MCA bus).

There's a growing trend, though, to offer peripherals that interface through a PC's parallel printer port. For one thing, just about every PC, regardless of form factor, has one. And with "smart" interfaces that can pass data that's actually destined for the printer through the peripheral, it's an extremely convenient interface method. In past issues, I've reviewed products from Micro Solutions that let you hook up floppy-disk and CD-ROM drives using this approach. You can also get parallel-port tape backup units from Micro Solutions and lots of other vendors, like Mountain Network Solutions.

ComputerEyes/LPT is an "outboard" frame grabber that interfaces through a PC's parallel port. This makes it quite suitable for use with just about any PC. Additionally, you don't have to worry about installing a card in your PC. Even if you're going to be using the device with a desktop unit, you can just hook it up when you want to capture a video shot.

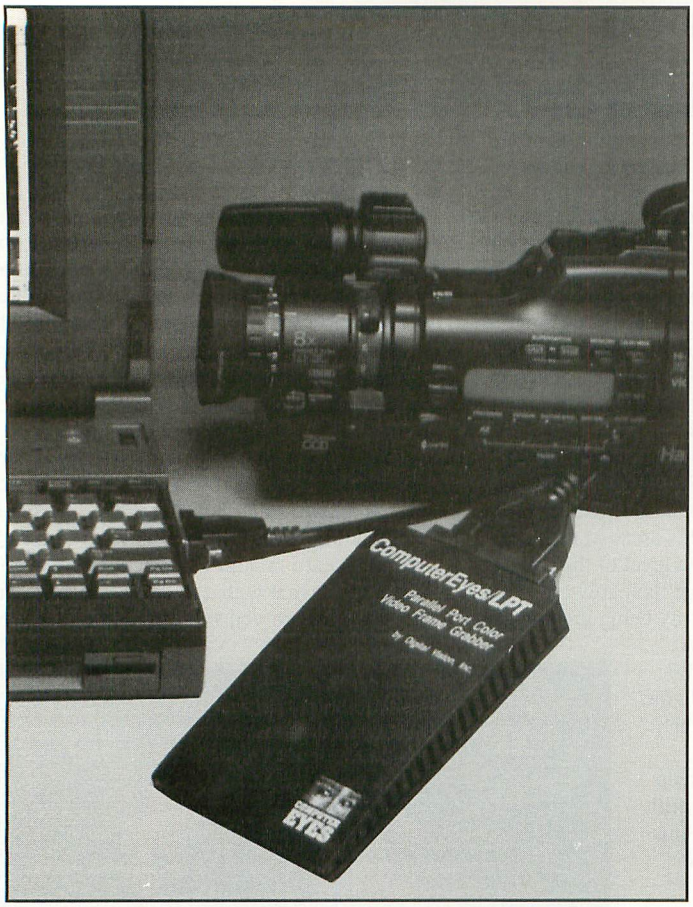


Digital Vision's TelevEyes/Pro converts VGA output to NTSC viewing on a TV receiver/monitor.

Actually, unlike some of the parallel-port peripherals now available, ComputerEyes/LPT doesn't have a pass-through. So you won't want to leave it connected to your PC when you're through using it.

The unit itself is palm-sized and comes with an ac power cube. It also comes with a cute little nylon carrying case that holds the grabber, power supply, cable and documentation. ComputerEyes/LPT retails for $399.99. Compared to the full-motion video cards now available, like Creative Labs' VideoSpigit, this price is a bit steep. You can get frame grabbers from a number of vendors for between $200 and $300. But they'll require an unoccupied expansion slot on your PC's bus, and you can't use them with a notebook PC.

In the interest of testing the unit under field conditions, I installed the software on a Zeos ColorNote and plugged ComputerEyes/LPT into ColorNote's



ComputerEyes/LPT is an outboard frame grabber that uses a PC's parallel port.

printer port. ColorNote is a 486 portable with a dual-scan passive-matrix display. It doesn't have quite the brightness and response of an active-matrix LCD, but at just over $2,000, it provides really usable 16-color VGA.

ComputerEyes' software is provided in two versions, one for DOS and the other for *Windows*. I tested the DOS version. The video source I used was a Minolta 8-mm Camcorder. I recorded my son Marc practicing one of his Karate forms. So there was plenty of motion in the segment.

The *Eyes* program used to grab a frame is the same software that's used with Digital Vision's other frame-grabber products, such as the /RT unit that resides in my desktop. I had no learning curve, but a novice would probably need at least five or ten minutes to feel comfortable. Before you can capture video, you'll need to set the video source (composite, S-Video, NTSC or PAL) and type (grayscale, 4-, 8-, 16- or 24-bit color). After the software is configured, feeding a video signal into the unit displays the signal's image on your screen. In the case of the color notebook I was using, there was a bit of distortion—the LCD just had trouble keeping up. When I froze the image, however, the display improved. Just to see the difference, I set the /LPT unit up with a 486DX/50 with 25-bit (16-million) color display. The difference is considerable. However, you also have to consider the format in which you'll be saving the frame. ComputerEyes software can save frames in Digital Vision's own format. So you can load them back in at a later time and modify them with the *Eyes* functions. But you can also save frames in Targa, .PCX, .TIF, JPEG and *Windows* .BMP. These other formats are more suitable if you'll want to drop the image into another application, such as desktop publishing, or an image editor like *Picture Publisher* or *Image Assistant*.

Capturing an image is as easy as clicking on the "freeze frame" choice on the image menu. Write the image to the screen to adjust and/or crop it, or simply save it to a file.

The quality of the image you get is dependent on a number of things. Even though capture is performed at screen resolution, it's important to remember that you can't improve resolution over that of the original image-acquisition device. Most camcorders and still video cameras use a CCD imager. Resolution on these devices has improved quite a bit over the last few years. But, unless yours is professional quality, the quality if the images will be correspondingly poorer. My camcorder is okay, but it certainly doesn't begin to approach professional quality.

The large degree of motion also had an influence on the images I was able to capture. There was a noticeable amount of blurring on many of the frames as I captured them. The *Eyes* software has a motion filter that helps "de-blur" the image. This helped a bit, but I got best results by selecting the "single-frame" option. A standard video frame is actually two frames that are offset by one scan line. Selecting only one of these frames cuts down the resolution. But with a really blurry action shot, it yielded a substantially better image.

The final consideration to take into account is what you'll be using the image for. If you're sending the image to a laser printer to obtain a hard-copy printout, you'll need one level of quality. Sending the file to a slide maker and having a separation made for offset printing requires a much higher level of detail. Frame grabbers are great for use that doesn't require a very high level of detail. As frame grabbers go, the parallel interface of the ComputerEyes/LPT makes it a particularly attractive unit.

The Big Picture

The previous two products deal with acquiring an image. The one I'm about to discuss is different. On occasion, I get roped into making a fair number of presentations. Sometimes these can be accomplished with a standard CRT-style monitor. With large groups, however, I often wind up renting a large-screen (29" or 31") A/V monitor. These give great results, but the rental fee is considerable. The last time I had to rent two of these units, I wound up paying more than $1,000 for three days use! Not that I begrudge this rental fee, since the units themselves sell for well more than $5,000, but it's a hefty price to pay when you need something a bit better than a 14" computer video monitor.

One way around this is a special LCD display panel that fits on an overhead projector. This works fairly well, but these panels are also expensive (especially the color ones), and the room in which a presentation is given must be darkened for the projected image to be visible. Even with the room darkened, brightness is frequently a problem.

The same Digital Vision folks who make the parallel-port frame grabber reviewed above make a line of products that

take the VGA output from a PC and convert it into an NTSC signal that can be fed into the VIDEO IN jack (or S-VIDEO input if your TV receiver/monitor offers it) on a standard TV receiver. There are two models in the TelevEyes line—an inexpensive one that performs most of the scan conversion in software and the TelevEyes/Pro, which is the unit I tested. At $799.99, the unit isn't cheap. At the same time, many businesses have a good-quality, nice-sized TV receiver/monitor somewhere in the office. For example, our office has a 27" Sony that's used with a VCR to make presentations to the employees. A similar size and quality unit will cost in the area of $700, which isn't a large price to pay if you have frequent presentations to make and certainly costs a lot less than a $5,000 A/V monitor.

There's not a whole lot to say about the TelevEyes/Pro. It's a compact box that measures about 9" square and a bit less than 2" in height. On its rear panel are two D-shell connectors for RGB IN/OUT and S-Video and RCA composite connectors for video input and output. A separate power supply is included, and there's a small cable that connects to one of the RGB IN/OUT connectors on the TelevEyes/Pro and to the VGA out connector on your PC. If you use the TelevEyes/Pro with a desktop PC or Macintosh (it's compatible with both), the CRT gets plugged into the other D-shell connector. With a laptop, the other D-shell connector remains unused. There's also a set of DIP switches that you use to set internal termination. The accompanying short but concise manual details the settings for desktop, laptop and Macintosh use.

Since this is essentially a hardware solution, there are also a few controls on the from panel. In addition to a power switch and LED indicator, there are three pushbutton switches labeled UP/YES, DOWN/NO and ENTER. You use these to page through on-screen menus that you can activate by hitting one of the front-panel pushbutton switches. These menus allow you to change centering (the conversion of VGA resolution to TV resolution doesn't quite completely fill a standard television screen) and flicker filters.

Connecting TelevEyes/Pro to a PC is a simple procedure. I tested it with two different notebook PCs, an Epson ActionNote 486 and a Gateway 2000 Nomad 450. With both notebooks, connecting the unit was just a matter of plugging the included cable into the VGA out jack on the notebook and the RGB IN/OUT D-shell connector on the Digital Vision unit. A standard phono plug went from TelevEyes/Pro to the Sony TV receiver/monitor I used. Plugging in the power cube, I turned on the TV, TelevEyes and notebook PC. Up booted the PC, with the screen displayed on the TV receiver/monitor. I ran a variety of programs, including *Windows*, with the screens displayed both on the notebook's LCD panel and on the TV screen.

Digital Vision will send you a copy of Macromind's *Action* when you return the registration card. TelevEyes/Pro also has a genlock feature that lets you mix video from a camera or VCR with computer-generated graphics. This process is accomplished in the hardware, using the UP/DOWN YES/NO buttons to set the genlock parameters. You can use the *Action* software to generate titles and other computer graphics, though almost any other package will also serve. This is great for special effects and titling when you bring the video output back out to a VCR instead of a TV set. I didn't receive the software in time to test it, but I've used *Action* in the past, and while it didn't particularly overwhelm me, I remember it as being capable and not particularly difficult to learn or use.

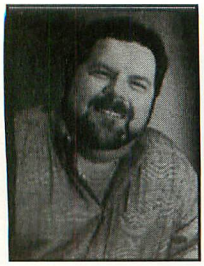
I really like TelevEyes/Pro, but it does have one limitation I need to mention. In testing it with two different notebooks, it gave me better results with the Gateway than with the Epson. Even with the flicker filters activated (and I tried all available combinations), the TV image from the ActionNote demonstrated a noticeable and distracting amount of horizontal distortion. It was a lot less noticeable (but still present) when using the Gateway. I'm going to try it with a few other units in the next month or so as I can obtain them, including a desktop or two, and I'll update you on this in a future column.

The bottom line is that the display, even though not up to the quality that you'll get on a $5,000 large screen monitor, is still quite acceptable for all but the most-critical presentations. I invited about a dozen people to examine the display as I was testing it, and the large majority of observers were greatly impressed. The only criticisms came from one person with lots of experience viewing expensive monitors. Even he opined that the Digital Vision unit was acceptable for general office presentation use. I agree. And $799 isn't an unreasonable price. ■

Products Mentioned

ComputerEyes/LPT, $399.95
TelevEyes/Pro, $799.99
Digital Vision, Inc.
270 Bridge St.
Dedham, MA 02026
Tel.: 617-329-5400

CIRCLE NO. 178 ON FREE INFORMATION CARD



Tom Benford

Multimedia

A Professional Sound Card and Sound Module and a Create-Your-Own Music CD-ROM

This new column is my vehicle for giving you concentrated coverage of the latest products and news concerning graphics, sound, motion video, MIDI and just about anything else that comes under the general umbrella of "multimedia" for PCs. Since there are lots of things happening in this dynamic area, I'll get the ball rolling right away with a new high-end MPC sound card.

Professional MPC Sound Card

The $595 Z1 MPC Sound Board from Antex isn't for everyone. It's a professional-caliber, high-end 16-bit sound card that offers compression in a multitude of formats. Compression is only one of several unique characteristics that set this board apart from all other competitive products. Antex boasts that the Z1 is the "most advanced MPC sound board available." After using it and comparing it against other sound cards, I must concur that this is no idle boast. Since it's designed and intended for professional use by system integrators, programmers and application developers as well as power users who demand (and can afford) the best, you won't find the Z1 card at your local computer store or discount warehouse.

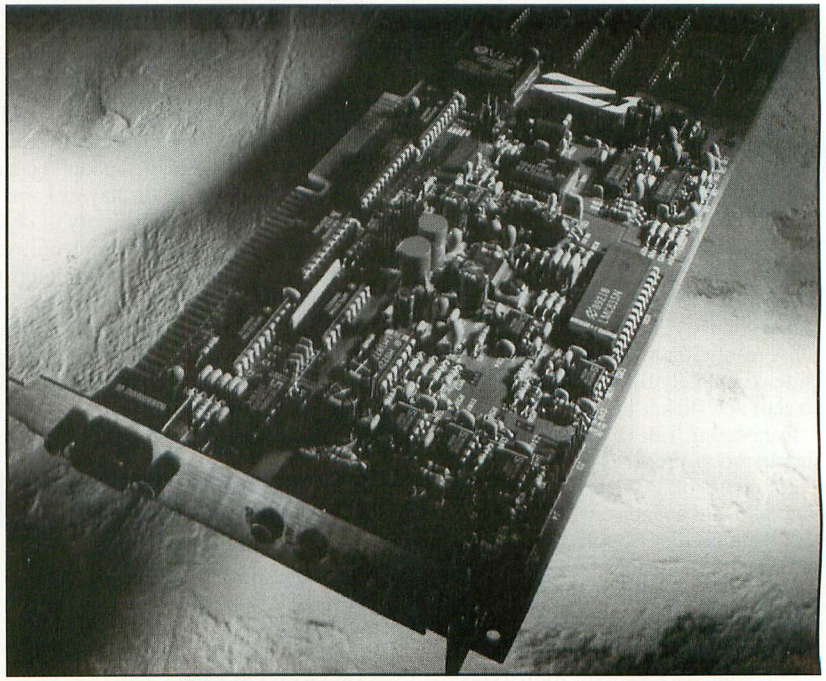
The heavily-populated full-length Z1 card requires a 16-bit slot for installation. On its mounting bracket are miniature phone jacks for line, microphone and auxiliary inputs and a line output. A 15-pin D-shell connector on the bracket accommodates a joystick or external MIDI devices. Additional pin header connectors are also provided on the card itself for internally attaching microphone, line and AUX input sources and CD-ROM audio. Also on the card are output pin connectors.

A 50-pin connector is integrated into the Z1 for attaching an SCSI CD-ROM drive, and a special set of headers is provided for attaching an add-on 32-voice synthesizer module (see below).

Since the Z1 is fully SoundBlaster- and AdLib-compatible, software designed to run with either of these cards works properly with this card. For sound generation, an on-card Yamaha YMF 262 (OPL3) synthesizer chip produces 20 voices with four operators. The card can be set via jumpers to use interrupt 2, 3, 5, 7, 10 or 11 and I/O port addresses 180, 220, 280 or 380. Consequently, the card features plenty of configuration flexibility to ensure non-conflicting installation.

The Z1 card offers realtime 4:1 compression in stereo in ADPCM (adaptive differential pulse code modulation), Microsoft ADPCM and DVI (digital video interleaved) ADPCM compressed formats. Additionally, it supports 3.73:1 compression, using CD-ROM XA/CDI (extended architecture/compact disc interactive) formatting. To the best of my knowledge, the Z1 is the only sound card to offer any and all of these formats. Audio files can be compressed at data sampling rates from 7.35 to 50 kHz in software-selectable increments.

The major advantage of the compression options supported here, particularly the 4:1 algorithms, is that by compressing audio data you have four times more disk space, compared to other cards available, with the added advantage of being able to record at



Antex's Series 3 Model Z1 Multimedia Digital Audio Adapter is a high performance 16-bit, broadcast-quality stereo sound card with digital signal processing, on-board CD-ROM interface, 4:1 compression and loads of other high-end features.

44.1 kHz, rather than settling for a lower sampling rate to save disk space.

Another advantage of compressing sound files is that it demands less overhead from your CPU. This is especially true of multimedia presentation work that incorporates full-motion video, animation and rendering, where 16-bit stereo sound can really put a strain on the system, resulting in jerky motion. Under the Antex compression scheme, the audio uses only 25% of the CPU's resources, compared to other cards with 44.1-kHz stereo sound. So the CPU is free to devote its muscle to video processing instead of to audio overhead.

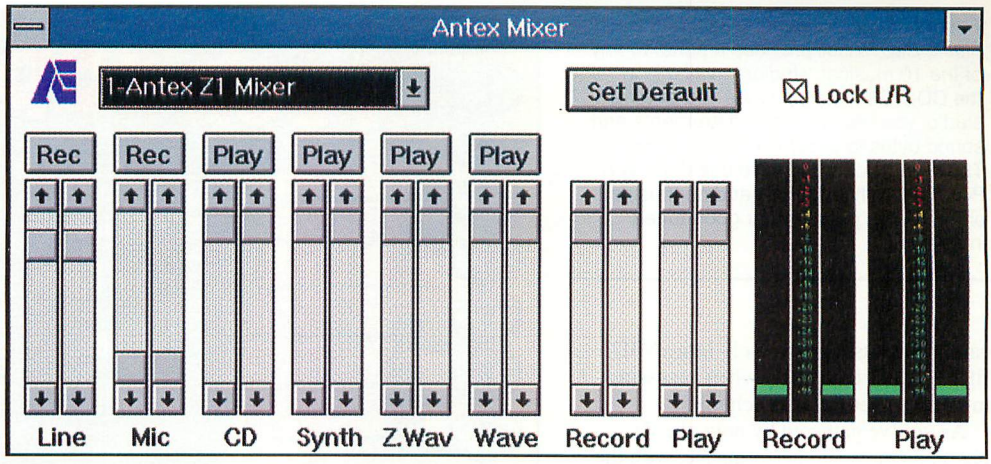


Fig 1. In Antex's Z1 mixer applet, Each channel can be treated as a discrete "device" in monophonic mode, permitting sound-on-sound (overdubbing) to be performed from a single board.

At the heart of the DSP-based Z1 is a fast 20- MIPS programmable Texas Instruments TMS320C52 digital signal processor. This feature is primarily intended for developers, integrators and advanced users who want to customize the card for specific applications. For example, TI currently lists a multitude of public-domain algorithms for special digital effects, including delay, reverb, phase shifting and more. Developers can also program the card for voice recognition, text-to-speech applications and tone-recognition.

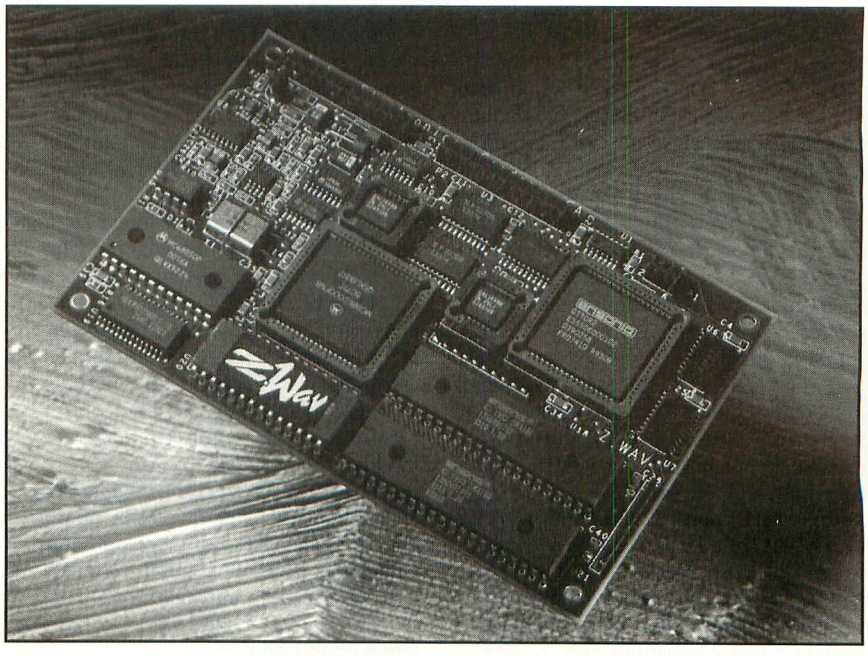
DSP also makes upgrading the card's capabilities an easy task, since signal processing is software-based, rather than hardware-constrained. New features, compression formats and effects are easily uploaded to the DSP using a simple software loader.

One of the really special features of the Z1 card is its ability to support dual monophonic-mode recording. This permits recording on the left channel while playing back sound on the right channel simultaneously, a great boon to anyone doing multimedia work, where it's advantageous to have "sound on sound" capabilities. If desired, DSP can treat the left and right channels of the line-in, CD-ROM in and output jacks as independent mono "devices." Since each "device" is associated with a unique .WAV file, each channel can act as a separate track. For example, you can play a voice file on one channel and a music file on the other, or you can record a voice file on one channel (for overdubbing) while playing music on the other. Doing this normally requires two sound cards with competitive products.

If the capabilities of one Z1 card aren't enough, you can have up to four Z1s installed in a single PC to obtain truly awesome capabilities. With each card operating in dual-mono mode, you effectively have the power of an eight-track digital-audio recording system on your desktop at a price that's significantly less than what the $10,000 or so you'd have to pay for a dedicated eight-track computer-controlled system.

Since the Z1 card is intended primarily for the developer and programmer, the supplied software is somewhat sparse. It consists of a diskette on which are located dedicated DOS drivers, the *Windows* mixer and the CD-ROM interface setup software. However, using all of the capabilities of the Z1 is easily accomplished via a "mixing console" applet that runs under *Windows* (Fig. 1).

MIDI is a subject that's near and dear to my heart. So I was particularly interested in the Z1's capabilities in this area and, again, I was suitably impressed with what I found. Antex added 128-byte data buffers and time-stamp components for both receiving and transmitting MIDI information for high-performance full-duplex operation. The result is that I'm now able to have uninterrupted recording and playback of even my most ambitious 16-channel MIDI compositions. The Z1 doesn't give me any of the annoying pops and clicks I've experienced with other sound



Antex's Z.WAV Sound Module is a daughtercard that attaches to the company's Z1 audio adapter and provides 16-bit wavetable synthesis. The Z.WAV can also be installed on the SoundBlaster 16-ASP card as an upgrade.

Fig. 2. The opening menu screen from *Rock, Rap 'n Roll* provides a portal to any of the 10 musical "studios" available in the CD-ROM version. Once you enter a studio, you merely select instruments and sound bytes to assemble complete songs. The program is so easy to use that even PC users with a "tin ear" and no musical prowess can put together good tunes in a snap.

cards when using extremely large MIDI files (greater than 80K) when accessing my disk to get the next "chunk."

As you've gathered by now, the Z1 is big on features and performance, with the specs to back it up. The card supports sampling rates of 7.35 to 50 kHz in software-selectable increments, and it offers a frequency response of 20 Hz to 20 kHz and a dynamic range of 80 dB. It should be noted that this is a *true* dynamic range, based on spectral analysis, rather than a blind translation of 16 bits into dynamic range specs of 90 or 96 dB. Based on the definition of dynamic range, Antex's specs reflect the Z1's ability to resolve signals at the –80 dB level. The card uses 64 times oversampling sigma-delta conversion hardware.

Sound Module

While the $395 Antex Z1 card by itself has more capabilities and features than most users will ever need or use, there are a handful of users out there who need even more extended musical capabilities than the Z1's OPL3 chip can provide. It's for these users that Antex produced the Z.WAV Sound Module, a true 16-bit wavetable MIDI synthesizer on a card.

The Z.WAV is a General MIDI-compatible sound module configured as a daughtercard that attaches to headers on the Antex Z1 card. Using the Ensoniq OTTO™ synthesizer engine, the Z.WAV uses 16-bit samples combined with wavetable synthesizer technology to provide incredibly good sound instrument samples. On-board ROM contains 4M of sampled sounds that produce 128 instrument voices, 47 drum sounds with 32-part polyphony and 16-part multi-timbrality. Access of the sounds and control of the voices can be done through any General MIDI file or MIDI controller device (such as a keyboard, guitar synthesizer, etc., connected to the Z1's external MIDI port). If you prefer working with MIDI from DOS, the Z.WAV/Z1 combination can also be used in that environment as an MPU-401-compatible synthesizer. The instrument set is Roland Sound Canvas-compatible, and 16 channels are directly supported.

Installation is very straightforward and clearly explained in the instruction sheet that accompanies the Z.WAV and accessory hardware items. Since the instruction sheet is also illustrated with clear drawings, installing the Z-WAV shouldn't be a problem for any reasonably-adept PC user. Supplied with the Z.WAV card are three 1/2" nylon standoffs, one 5/32" nylon standoff and seven 1/4" Phillips screws. The four nylon standoffs are already attached by four screws to the Z.WAV module, as shipped, and the remaining three screws are used to attach the module to the Z1 card.

On the Z1 card is a pair of header connectors located at the trailing edge of the card and another header connector at the leading (bus connector) edge. Counterpart pin connectors on the Z.WAV daughtercard mate precisely with these headers. On early model Z1 cards (such as mine), a modification must be made to the *J12* connector. It consists of removing pin 1 from this eight-position connector. This is easily accomplished using wire nippers or small diagonal cutters. You must snip off the pin at the insulating base. On later-model cards, this modification isn't required.

Antex also advises that if you aren't comfortable making this pin-removal modification yourself, you can send your older-model Z1 card to the company and a technician will make the modification for you. With the clarity of the instructions and the excellent illustrations provided, however, I don't think anyone who has ever installed a PC card will have a problem with this procedure.

Three holes are provided on the Z1 card to accommodate the attachment screws that marry the daughterboard with it. You insert three Phillips screws into these holes from the bottom of the Z1 card and screw them into the nylon standoffs that protrude from the Z.WAV module (instructions explicitly caution against using a power screwdriver for tightening these screws because it's easy to strip the nylon standoffs). The fourth standoff doesn't receive a screw and functions as a spacer that keeps the components of the two cards from touching each other.

Since the Z.WAV is a daughterboard that attaches to the end of the Z1 farthest from the mounting bracket, it doesn't require a slot of its own and won't interfere with installation of another peripheral card in an adjacent slot in most installations. It's extremely important that you make certain that no other card comes in contact with the Z1 or Z.WAV cards. This can't be overemphasized, since both the Z1 and Z.WAV cards contain data in ROM (the DSP and wavetable library, respectively) that could be erased by a short. When you finish attaching the Z.WAV to the Z1, you plug the combined assembly into an available full-length slot in your PC to complete hardware installation.

Next, you install the supplied software to make it possible for you to access the enhanced music and sound capabilities of the system. You select the Control Panel from the Main group in *Windows* and then MIDI Mapper. A box with Name is seen to the left. Clicking on the arrow to the right of this box brings up a list of available devices. *Selecting* Antex Z.WAV and then clicking on Close completes software installation. At this point, you're ready to start enjoying sound and music like

you've never heard before on your PC.

The Z.WAV module can also be installed on a Creative Labs SoundBlaster 16-ASP sound card as a high-performance alternative to the WaveBlaster synthesizer.

The combination of the Z1 and Z.WAV represents a sizable investment that's definitely worthwhile if you're a user who needs and/or wants the epitome in sampling, recording, mixing and playback options and digital signal processing and wavetable sound and music generation, while still maintaining SoundBlaster compatibility. If the top of the heap is what you're after, this combination is it.

Rock, Rap 'n Roll

While I'm on the subject of audio and music, I'll close this column with a review of a very interesting software product called *Rap, Rock 'n Roll* ($79.95, CD-ROM; $59.95, floppy disks) from Paramount Interactive.

Lots of folks enjoy music and wish to "create" their own but lack the formal training or talent required to do so with a musical instrument. It's for these people especially that *Rock, Rap 'n Roll* will have its greatest appeal, although musicians of various skill levels will also find use and merit in this program.

The basic concept and construction of *Rock, Rap 'n Roll* is built upon samples of musical passages, effects, rhythms and vocalizations that you can assemble to create verses, choruses and even complete songs by simply selecting "chunks" and arranging them in desired order. To keep things simple, the various musical styles are arranged into a suite of 10 separate "studios" (Fig. 2) on the CD-ROM version (there are only eight studios on the floppy-disk edition), and the program runs from *Windows*, using any *Windows*-supported sound card.

Since all of the musical snippets are sampled and stored as .WAV files on the disks and CD-ROM, it isn't necessary to have full-blown MIDI capability or extensive sound-synthesis capabilities on your host system. Virtually any sound card that's capable of playing back .WAV files sampled in eight-bit resolution at 22 kHz will suffice.

When the program first opens, you're presented with a selection of available studios that serve as the portals to the musical genre in which you're interested. Studio offerings consist of African, Big Band, Blues, Latin, Rap, Reggae, Rock Sampler, Soulful Sampler, Street Jaz and Techno Pop. So selection of contemporary stylings is fairly inclusive.

Upon selecting a studio, the actual musical-assembly process is ready to begin. Depending on the studio you've chosen, a screen like the one shown in Fig. 3 is presented. From here, you merely select musical loops (called "groove loops") from the 10 presented, assembling them by dragging them into the Song-A-Lizer section at the bottom of the screen in any desired order to create a completed tune. Each loop is from two to eight bars in length, and you can audition each loop and rearrange the order of the loops to your liking at any time. Hence, the combinations and varieties you can produce are limited only by your imagination.

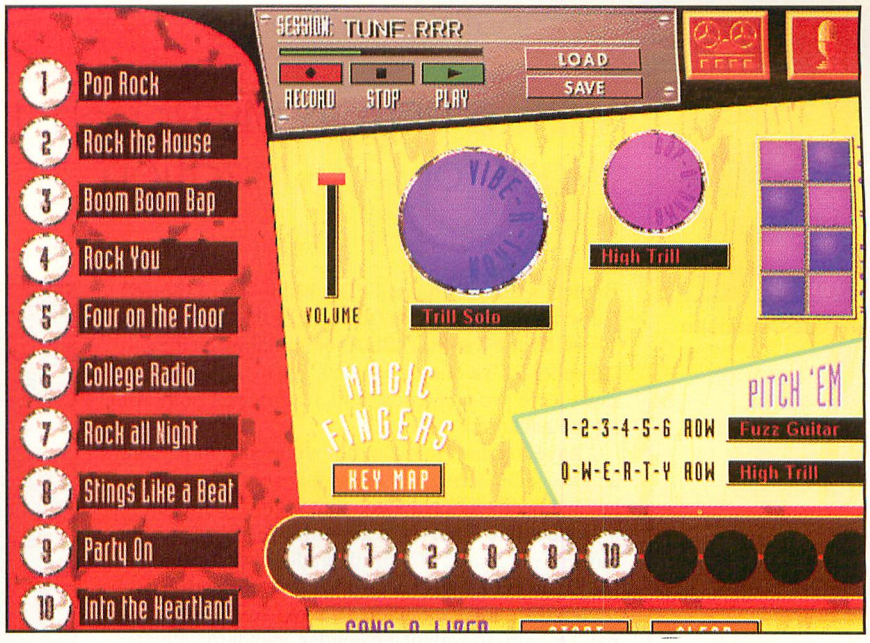


Fig. 3. Songs are assembled inside the studio by selecting "groove loops" from the column at the left and dragging them in the desired order to the song bar at the bottom. When you're happy with what you've created, you click on the recorder icon at the top of the screen to save the song (recorder controls are visible here). You can also add your own vocals to the song by clicking on the microphone icon. Other embellishments, such as adding volalizations, trills and other effects, are also possible.

As your loops are playing, you can "jam" along with the background, using the hot buttons (trills and vocalizers) or your computer's keyboard to embellish your composition. A neat feature is the key map that prevents you from hitting "sour" notes. Only those notes that are harmonically correct with the current passage are active using this feature.

Voc-A-Lizer buttons are another neat provision of the program. These insert prerecorded vocalizations ("Yeah," "Oh-owe-owe baby" and other James Brown-like utterances) into the musical scheme of things to give it a markedly "human" sound.

Two icons at the top of the "room" screens permit you to record your creations, preserving them as eight-bit, 22-kHz .WAV files that you can use any way you wish. A tape-recorder icon drops down a record/stop/play/load/save graphical applet for these functions, while a microphone icon provides the facility for recording your voice (or any other sound you wish) to use in your music.

I was very impressed with the amount of features that have been built into this program that move it beyond a recreational novelty and into the realm of functional creative software. While you might not want to use it as the basis for doing a movie soundtrack or a symphony, it's certainly a good tool for roughing-out musical ideas and backgrounds before cranking up your MIDI gear and producing fine-tuned tablature. It's a fun product that delivers lots of value for the price. ■

Products Mentioned

Antex Series 3 Model Z1 MPC Sound Card, $595
Antex Z.WAV Sound Module Daughtercard, $395
Antex Electronics Corp.
16100 S. Figueroa St.
Gardena, CA 90248
Tel.: 310-532-3092

CIRCLE NO. 172 ON FREE INFORMATION CARD

Rock, Rap 'n Roll, $79.95 CD-ROM; $59.95 Floppy Disks
Paramount Interactive
700 Hansen Way
Palo Alto, CA 94304
Tel.: 800-821-1177

CIRCLE NO. 173 ON FREE INFORMATION CARD

By Joe Desposito

Computing On the Go

With a PDA in My Pouch, I'll Never Again Want for Organization

Barlett's doesn't have a PDA section, so I figured I'd write my own quote (the title of this column), inspired by the Tandy Z-PDA, better know as the "Zoomer." I've concluded that, for me, Zoomer is must-have product, even at its list price of $699. But let me backtrack a bit.

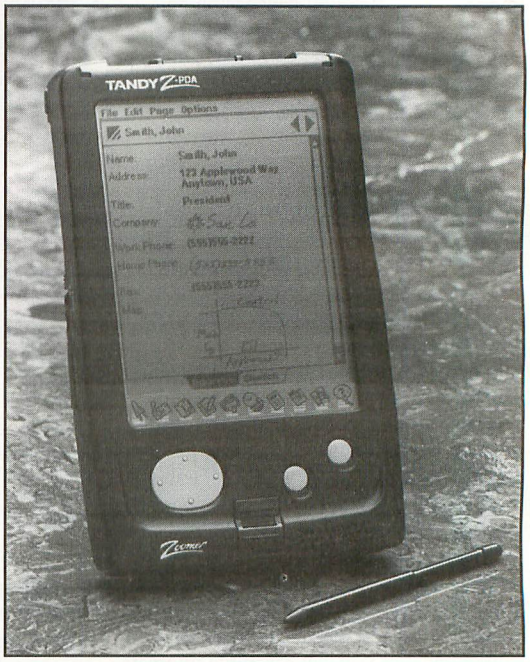
I have to admit that I'm not an organized person, and my short-term memory is just about gone. If anyone needs a PDA, I do. Although I've longed for a product like Tandy's Zoomer for many years, I haven't purchased any of its predecessors, such as the Casio B.O.S.S. or Sharp Wizard. Instead, I've used a telephone and address book, weekly "pocket pal," month-at-a-glance calendar, standard calendar and thousands of Post-It notes to help keep myself organized. I carry the phone/address and pocket-pal books in my briefcase, the month-at-a-glance is on my office desk and the standard calendar is on the wall by my home desk. Post-It notes wind up in my shirt or pants pockets, my wallet and all over my home and office desks. In short, I'm an organizational mess.

Enter the Tandy Zoomer. Zoomer handles the jobs of all the organization tools listed above and, best of all, keeps everything in one place. Before launching into the software details of Zoomer, let's take a look at the hardware. Zoomer packaging is excellent. The dimensions of the case are about 7" x 4" x 1", and weight is about a pound. It's a little too large to carry comfortably in a pocket, but it's a perfect size for a briefcase. Its 4" x 3" LCD screen is protected by a double-hinged cover that can be raised up and tucked under the unit.

Ten permanent icons reside at the base of the screen. Explanations for these and other icons are printed on the rear of Zoomer's cover, which makes Zoomer a snap to learn and use. A joystick-like button and two standard buttons are integrated into Zoomer and are located just below the screen. Speaker holes and a latch for the cover are just below these buttons. On the right are contrast and volume controls and an on/off switch. On the left are a Type II PCMCIA slot, an ac-adapter socket and a miniature RS-232C connector. At the back is a window for infrared communication. At the front are a headphone jack and pen-docking shaft, which is for a telescoping plastic pen that's kept here when it isn't in use.

The battery compartment, which holds three AA cells, is at the bottom of Zoomer's case. The battery last for about 100 hours. Also on the bottom is a pushbutton latch for ejecting a PCMCIA card.

The above rather bland hardware description doesn't begin to convey how nice Zoomer feels in one's hand. With its hard rubber feel, the case is easy to carry around, plop in a briefcase, set on a table, etc. The pen is a little skimpy, but by simply sending in the registration card, you receive a plastic-tipped pen with the look and feel of a Waterman. With this pen, writing on Zoomer's screen is as natural as writing on paper.



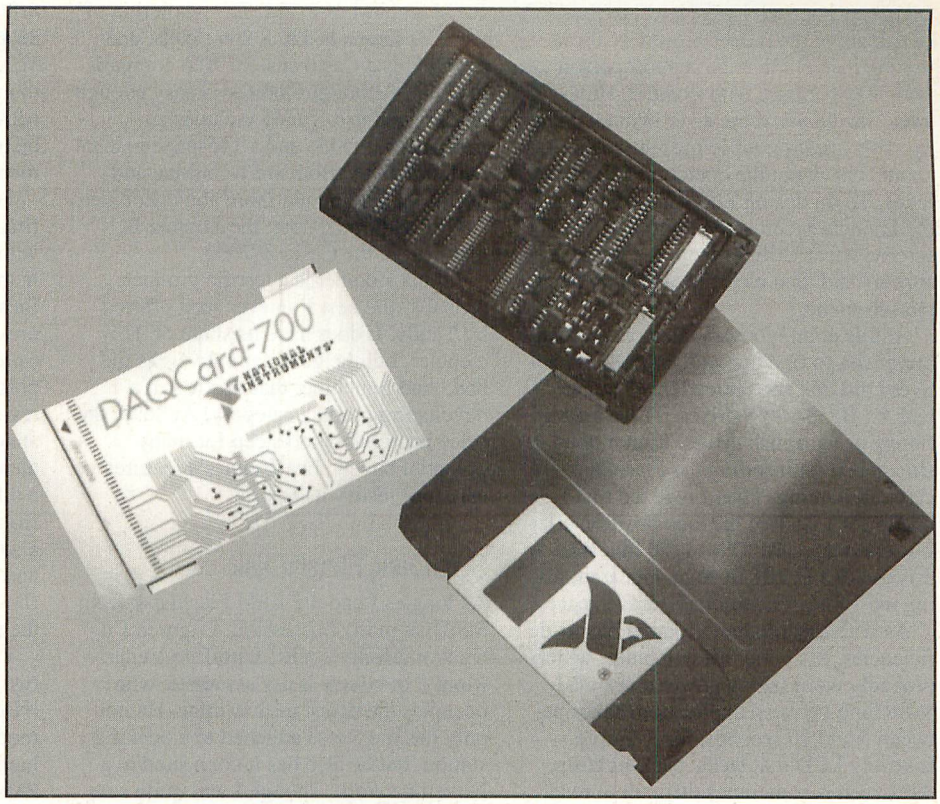
Tandy's Z-DA—more fondly called Zoomer—personal digital assistant.

Rather than present a straightforward review of Zoomer's software, most of which is from Palm Computing, I'll give you the details of how the software unfolded before me. To start with, this is the first pen-based product I've ever tried. So the natural thing for me was to test Zoomer's pen-recognition capabilities. My first effort was entering a name and telephone number into the Address Book. On my first attempt, I wrote too fast and too small and got gibberish in return. By playing around a little, varying the speed and such, recognition of printed letters only became acceptable. But, I thought, it was too slow to be acceptable. Then I noticed that I could invoke a typewriter keypad on the screen. This let me enter text much more accurately but at still too slow a pace for my liking.

Next I tried the Date Book. Again, I expected Zoomer to convert my printing characters into on-screen text. This was disappointing, too. I tried to enter an item on the *To Do list, but this* took too long. It was tedious. Then I finally realized that there was little need for recognition in the Date Book. I just wrote down an item and left it in my own hand-

writing. This is known as PowerInk. Zoomer accepts handwriting at about normal pen-and-paper speed. Items in the To Do list remain from day to day until you mark each completed. When you move to the next day, completed items are removed from the list. But if you backtrack, the items reappear. This is helpful if you want to recall when you completed a particular task.

The Date Book consists of three parts: Event, To Do and Sketch. The hierarchical Event portion starts with a six-month calendar that condenses to a month and then to a day. The day is divided into 12 hours. If you need to schedule a meeting, for instance, you can enter the time and sound an alarm, if you wish. The alarm on my test unit, rather low even at full volume, wasn't too helpful. I found the Date Book to be very useful, even though it lacks features of a desktop product like the Lotus Organizer. For one thing, you can't link events to the To Do list; for another, you can't link items from the Address Book, such as phone numbers, to an event. One nice feature, though, is the ability to enter an item once and then have it repeat every day, week, month, etc.



National Insruments PCMCIA DAQCard-700.

The next thing I tried was the Note Book. At first, I didn't find this to be too useful. (I used the Date Book much more often.) Then I realized that I could assign names to each note and arrange them in outline form. Now the Note Book became an extension of my To Do list. For example, I labeled one note "Grocery List" and entered items there instead of on the To Do list. Of course, one note was labeled Zoomer. I kept running notes of my observations on this page and others, in outline form.

Another piece of software I found useful was Zoomer's calculator, which pops up over any application in which you're working. You enter numbers by tapping on the on-screen keys with the pen or by writing them into the calculator display.

There are lots of other things to play with on Zoomer, most of which I tried but didn't spend too much time with. Foremost among these is *Pocket Quicken* from Intuit. If this had been my Zoomer, I'd have used this piece of software to learn *Quicken* and then buy a full-blown copy for my desktop machine. It seems like the perfect software for keeping track of expenses, especially business ones.

There are a world clock and a few games—solitaire, an Othello-like game called Uki and a card game called Pyramid. There are also a 50,000-word dictionary, 100,000-word spell checker, 660,000-word thesaurus, translator in 26 different languages and form calculator. The last provides general conversions—such as Fahrenheit to Celsius—and financial conveniences, such as calculating the amounts for several people splitting a dinner bill. There are also lots of other miscellaneous information—like as a nutrition guide, international dialing codes, US area codes, etc.

Zoomer includes software specifically tailored to connect to America Online, a somewhat limited service that includes news, airline schedules (you can book airline reservations through the EAASY SABRE Travel Service), stock quotes, electronic mail, and product support. Tandy provided a pocket modem and some free air time for me to test the communications features of Zoomer. All worked well through Zoomer's built-in serial port, though it seems that a PCMCIA modem would be better way to go. I was successful at sending a fax through America Online, which cost an additional $2.

I didn't use Zoomer for any other communication functions. There's the possibility of transferring information to another Zoomer through the infrared link, though I didn't have another unit to verify this capability.

Here are some additional observations I made. I loaned Zoomer to about 10 other people, ages 13 to adult and male and female, in grammar school, high school, college and the work force. Everyone liked it. If Zoomer ever falls in price to the magical $199 mark, Tandy will sell more of them than Commodore sold C64s.

I need to mention one more thing about the Address Book. It contains 20 fields and works as a database. Any text you enter you can search for. Four of the fields are customize-able, which means that you can create simple databases to keep track of, for example, your compact-disc or audio-tape collection.

Zoomer uses a version of the GEOS operating system from GeoWorks, which uses icons, file menus, folders, files, etc. For the most part, this is transparent to the user. But if you know what you're doing, you can create several different Address Books, Note Books, etc., and keep track of them as you would on your desktop computer.

Tandy provided one PCMCIA card, a 1.8M FlashDisk from SunDisk Corp. Knowing that a PCMCIA card simply can be placed in a slot at any time, whether a computer is on or off, that's what I did. Zoomer gave no indication that the card

had been inserted. I gave a call to SunDisk to ask about the proper procedure for inserting the card, but the support person had no experience with Zoomer. However, he did ask if the drive symbol came up. This question made me realize that I should check out the operating system icons. To do this on Zoomer, you select the Launcher icon at the bottom of the screen, select Utilities from the menu that appears and then pick File Manager from the sub-menu.

At this point, you can click on the disk-drive icon to find out which drives are active. I did this and noticed that Zoomer had A:, B: and SYS drives. These aren't floppy or hard-disk drives. Rather, they're silicon drives. Inserting the FlashDisk card did nothing. Then I realized that I had to set a latch to the lock position after I inserted the card. Once I did this, a C: drive with a PCMCIA logo appeared, giving me 1.8M of additional storage space.

As with any product, Zoomer has its deficiencies. It's not a fast computer, which probably would drive power users mad. Switching between applications takes between 5 and 10 seconds, for example. Like any LCD that lacks back-lighting, the screen is sometimes difficult to read. There's also no easy way to import information from desktop applications, such as phone numbers already stored in Lotus Organizer, into Zoomer. You're supposed to be able to link to a desktop PC through the serial port, but it wasn't clear to me how to do this, nor were the possibilities for data transfer. Apparently, this functionality is available only as an option from Palm Computing (see below).

Zoomer does not shine as a communication device simply because it doesn't have a built-in communication program, other than the one used to link to America Online. This seems a great oversight to me. Something I found annoying was having to reach for the on/off switch every time Zoomer shuts itself down. It seems reasonable that the buttons below the screen could be used to revive Zoomer from "sleep" mode.

Before I wrap up my comments on Zoomer, I'll give you a few technical details. Zoomer has 1M of RAM and 4M of ROM. The resolution of its LCD screen is 320 x 256 pixels, and the CPU is a Casio custom X86 compatible chip. Although Zoomer is easy enough to learn and use, Tandy includes an instructional video and a 145-page manual with this PDA. Both are well done and useful for finding out more about Zoomer.

One additional note: the Zoomer is identical to the Casio Z-7000.

I think Zoomer is a terrific product, probably the best I've ever seen offered by Tandy. It does have its share of deficiencies, but the good far outweighs the bad. And remember that this is still a developing product category. At $699, the price is probably too steep for many potential buyers, but Zoomer's features certainly justify its cost.

SunDisk FlashDisk

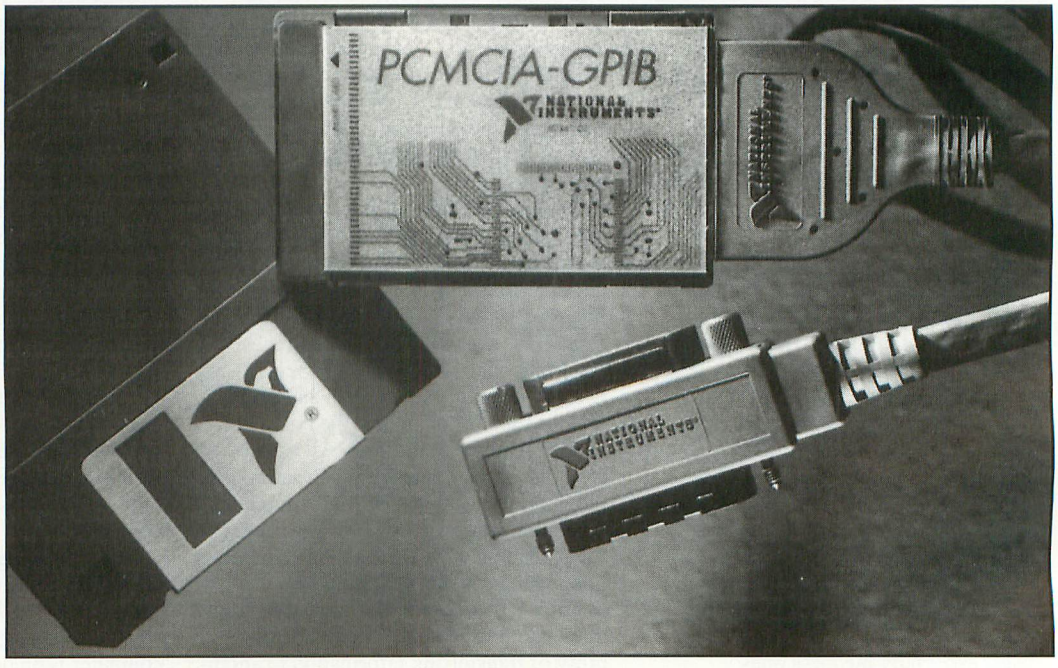
As long as I had the 1.8M FlashDisk from SunDisk in my possession, I figured I'd try it on Monty's NEC UltraLite Versa. Monty, of course is my associate, who occupies the office next to mine. He not only has the Versa attached to a docking station, but he also has it connected to a Novell network. Though I was quite sure the PCMCIA card wouldn't work as advertised, I tried it just the same. Sure enough, I slipped the card in the socket and elicited no response. So I called SunDisk. The support person there reminded me to look for the drivers for socket services, card services and ATA in the CONFIG.SYS file.

I checked CONFIG.SYS and found the following PCMCIA device drivers: SS365SL.EXE, CS.EXE, S_IDE.EXE, SCARD29.EXE and CIC.EXE. It isn't clear to me what each driver does, but I read a README file, and everything seemed to be in order. However, the Versa wouldn't recognize the card.

I decided to call NEC tech support. The first guy I talked to spent about 15 minutes with me, making sure I had the correct files in the CONFIG.SYS and AUTOEXEC.BAT files. When I confirmed that the files were present, he was stumped. I hung up and called back SunDisk. This time, the support person told me that NEC had put up revised drivers on Compu-Serve. Being annoyed that the NEC person didn't tell me about this, I called the company back. I got a different support person, and he confirmed the existence of the new drivers. He also gave me the number for the NEC BBS and told me exactly where to find the file—a compressed file that contained all the updated drivers.

I downloaded the file, which took over two hours at 2400 baud using XMODEM. (Now that's a reason for upgrading my modem and comm software. It sure would have gone faster at 14,400 baud using ZMODEM.)

I removed the Versa from the docking station and network and installed the new drivers. When I inserted the FlashDisk, I heard a short tune. I checked for the existence of a new drive and, sure enough, it was there. Then I reconnected the Versa to the docking station and network. Connecting to the network blew away the PCMCIA drive, which was replaced by a net-



National Instruments PCMCIA-GPIB card.

work drive. Monty also tells me that he has a 120M hard disk in the docking station that "disappeared" a few weeks ago.

I didn't have time to track down all these problems, but I hope to solve them by the time I write my next column. The Versa has a floppy drive (A:), a hard drive (C:), a docking station drive (D:); and network drives F: through Z:. The challenge is to get all drives, including the docking station drive and the FlashDisk running at the same time.

New PCMCIA Products

Here are two interesting new PCMCIA products. First is the National Instruments DAQCard-700. This low-power Type II data-acquisition card has a 12-bit A/C converter with 16 single-ended or eight differential analog inputs, an 80kS/s sustained sampling rate, 16-sample FIFO A/C buffer, multiple-channel scanning, and ±45-volt over-voltage protection with power on or off. You can configure the voltage input range to +10, ±5 or ±2.5 volts, with an analog signal resolution of 4.88 mV in the ±10-volt range.

The DAQCard-700 also features 16 lines of TTL-compatible digital I/O configured as eight-bit input and output ports and two user-available 16-bit counter/timer channels. All card functions are software-configurable. The PCMCIA bus interface has 16-bit data paths with interrupt-generation circuitry. Software included with the card are NI-DAQ library of data-acquisition functions and DAQWare ready-to-run software system that contains analog, digital and counter/timer I/O routines. Price of the DAQCard-700 is $695.

National Instruments has also announced an IEEE-488 interface for the PCMCIA bus. The PCMCIA-GPIB kit includes the card, NI-488.2 software and a custom cable. Price is $595.

Zoomer Software Option

PalmConnect links the Tandy Z-PDA or Casio Z-7000 to a PC. The software can be used to back up Zoomer data to a hard drive. Also, once you've linked the PC and Zoomer, whatever you type on the PC's keyboard can be entered right into Zoomer. If you have any addresses stored in an electronic organizer or database on the PC, *PalmConnect* lets you download that information into Zoomer. *PalmConnect* is compatible with all electronic organizers and PC databases that export comma-separated values.

PalmConnect lets you work with Zoomer's Address Book, Date Book and Note Book on a PC. You can view all three applications simultaneously and switch from one to another with a single click of your mouse. You can transfer both text and *PowerInk* back and forth between Zoomer and PC. *PalmConnect* lists for $119 and includes a Zoomer to PC cable.

Products Mentioned

Tandy Z-PDA (Zoomer)
Radio Shack
700 One Tandy Center
Ft. Worth, TX 76102
Tel.: 817-390-3300

CIRCLE NO. 174 ON FREE INFORMATION CARD

FlashDisk 1.8
SunDisk Corp.
3270 Jay St.
Santa Clara, CA 95054
tel.: 408-562-0500; fax: 408-562-0503

CIRCLE NO. 175 ON FREE INFORMATION CARD

DAQCard-700, PCMCIA-GPIB
National Instruments
6504 Bridge Point Pkwy.
Austin, TX 78730
Tel.: 512-794-0100; fax: 512-794-8411

CIRCLE NO. 176 ON FREE INFORMATION CARD

By Yacco

GUI Guts

CPU Upgrade, CPU Cooler, Recovering Hard-Drive Data, Running *Windows* under Unix

All the developers I talk to these days are raving about how good *Windows* 4.0 is going to be. They're all working with the beta version now and seem to love it. As near as I can figure, it's going to have many of the benefits of OS/2. At the same time, OS/2 may be showing signs of movement. The way it's worked until now, IBM has been willing to spend a fortune to tell us how much we're loved, but it hasn't shown us much affection. A few developers are just beginning to see a change in this relationship. Enough applications are showing up for OS/2 that it's going to make sense to start covering them soon—assuming of course, that IBM continues to make its subtle change.

Meanwhile, while these details are being worked out, there's something new you can do, besides adding memory, to improve the performance of the *Windows* you're using today. Not that memory shouldn't still be at the top of your list. Buy all you can afford, at least 8M if you run multiple applications and as much as 16M if you need it. But after you've loaded all the empty sockets on your motherboard, there's now something more you can do.

Cyrix offers a processor replacement for the 386SX chip, with 486-instruction-set compatibility, for several years. Now it has developed a line of processor upgrades that replace 386DX chips with 486 equivalents. The Cx486DRx^2 is instruction-set-compatible with the i486 and faster than the chips it replaces. It doesn't include a math coprocessor like the Intel i486, which makes it more comparable to a 486SX than to a 486DX. But unlike the 486SX, it can support an ordinary 387 math coprocessor.

The Cx486DRx^2 utilizes Cyrix's Cx486DLC processor, a single-cycle CPU with 1K of internal cache. Yet, a patented cache-coherency technology permits the upgrade to use its cache in a 386 environment. Moreover, the Cx486DRx^2 is clock-doubled. That is, it runs internally at twice the clock rate of the external system. So not only do you gain the 486 instruction set and a cache with this upgrade, you double the rate instructions are executed in the CPU. Cyrix claims processing improvements in excess of 70% can be realized. An improvement of 50% to 60% isn't uncommon for many applications (some benchmarks indicate more than 100%).

Cyrix upgrades are available for systems with 16-, 20- and 25-MHz. clocks and provide processing rates of 32, 40 and 50 MHz, respectively. They fit into an 80386 socket, but the 20/40 and 25/50 models also require clearance for a heat sink. Cyrix includes the heat sink, as well as cache software, a chip-extraction tool and a comprehensive installation manual in its kit. The manual is a good one. It covers potential pitfalls like the poorly marked pin orientation of the IBM 9314 processor. (There's even a little arrow-shaped label to mark the pin when the processor is removed.) Units are available from Cyrix, as well as Texas Instruments, which produces them under license. A number of sources are selling upgrade kits based on them, including distributors like Kingston Technologies.

Cyrix lets you upgrade a 386SX PC to 486-instruction-set capability with its new Cx486DRx^2 chips.

Kingston also offers an upgrade for certain Toshiba notebook computers based on the Cyrix 386-SX replacement. However, in addition to requiring their own clearance, these chips have one other limitation. Portable upgrades are designed to clip directly onto the chip they replace. So, they work only with machines that implement a line that lets the upgrade switch off the CPU it replaces. Not all 386SX-type CPUs implement this line, making this upgrade more of a challenge for typical end users.

Blowing It

Although Cyrix provides heat sinks for its faster upgrades, clock-doubled CPUs can be a source of heat problems, particularly for machines that weren't designed to handle them. Unfortunately, heat problems aren't always limited to machines that weren't designed for these chips. Environment can be a factor, too. If you're having a problem with an upgrade or any clock-doubled system, or a Pentium or other processor for that matter, you may find relief with a new product from PCubid Computer Technology. The $40 CPU Kooler is just a tiny muffin-style fan mounted to

a sink that sticks to the top of your CPU. Clearance of about 3/4" is required to effect installation of the CPU Kooler.

Interestingly, CPU Kooler was originally developed for a military application in an un-vented (sealed) container, which gives you an idea how effective a sink can be when there's air movement directly over it. PCubid provides a stick-on thermometer you can use to determine if your CPU's temper- ature is more than 80% of its operating range and recommends installing the fan if it is. It could also make the difference between shutting down your computers or being able to run them if your air-conditioning should fail.

You might want to consider this product as a backup for your main system fan as well. The company claims that the Kooler will prevent CPU temperatures from exceeding ambient temperatures by more than 10° versus as much as 80° F or more without it. If your fan should fail, this temperature could easily exceed the operating range of your processor. A table provided by the company lists temperatures various CPUs reach when operating in free space without a fan at an ambient temperature of 76° F. A 33-MHz. CPU hits about 170° and a 50- or 25/50-MHz. CPU hits about 190°. Intel CPUs can begin to fail at temperatures above 180°. Considering that a CPU failure can corrupt your data, directory structure or allocation tables, if it occurs during a write operation, it's a worthwhile investment.

In fact, installing one of these Koolers in every system could result in more savings than all of the new green PC features vendors are starting to offer by permitting the air-conditioning load for an office area to be reduced. People can usually operate at higher temperatures than the computers they use. I personally dislike the cool temperatures my machines prefer. So, I'm always pushing their limits, adding to their thermal stress and shortening their lives. Are you doing the same thing without realizing it? If you get occasional parity errors or other memory-related problems, you probably are. You've just been lucky that your CPU hasn't taken a more serious dump on you.

Murphy's Law

So, maybe it's already too late. You pressed your luck, Murphy stepped in, and you've corrupted your hard disk. PCubid's literature includes one case history in which a CPU failure, which occurred during an air-conditioning outage, resulted in corruption of the file-allocation table. It cost the company involved $500 to send the drive in for repairs. Those repairs weren't to the physical elements of the drive, only to the recorded information on it. Fortunately, if you run into such a problem, there are lots of new solutions that cost a far less than sending the drive into the shop.

I've haven't written about new versions of *Disk Technician Gold* for a while. *Disk Technician* now supports MS-DOS 6.2, PC DOS 6.1 and Novell DOS 6.0, as well as the latest *Stacker*, *SuperStor*, DoubleSpace and *DoubleDisk* compression programs. It can recover almost any error if you run it long enough, but it's greatest advantage is that you can use it on a regular basis to catch errors while they're still soft enough to recover quickly. *DT* remains the only one tested, approved and recommended by Seagate. It runs in the background, too, and is fully compatible with *Windows*. Whenever you do a read or write, you may notice its icon flashing briefly in a corner of your video screen.

Gibson Research has a brand new version of *SpinRite* that's a complete rewrite of the product. *SpinRite* 3 now purports to use statistical error analysis and data recovery that sound, at least on the surface, a lot like the methods used in *Disk Technician*. However, the company that develops and sells *Disk Technician* claims that no other product can use its statistical methods, which involves comparing the time it takes the controller to respond to read requests. Weak sectors eventually return valid data, but they take longer because it takes several reads. This is how *DT* determines when a sector is starting to flake out and go bad. The company claims that no one else can do this, which leaves it as the only company that can anticipate a hard error before it occurs. I've been depending on *Disk Technician* for this feature for several years with good results.

Gibson has another technique for finding weak spots. It uses special moving-flux patterns of high and low signals and tries to exceed the drive's ability to read the low signals. The theory is that low signals won't be readable on weak areas of the drive surface.

SpinRite's new DynaStat data-recovery technology has several prongs in its attack. First, it recovers data by repeatedly reading it. DOS ordinarily limits read attempts to a fairly small number before it quits. However, a program that circumvents DOS can read a sector far more often. *Disk Technician* has a procedure like that, too. The company claims that it will eventually recover lost data from all but the worst surface damage. Gibson also employs two other methods in DynaStat. One is to wiggle the heads in hope of approaching the data from a slightly different angle that enables a read. The other statistically averages the results of many reads and creates a most-likely reconstruction of the data. If DynaStat isn't entirely successful, it can at least increase the amount of data you recover.

Gibson also claims to work directly with an IDE drive's integrated circuits to low-level format areas of the drive. *Disk Technician* doesn't make this claim. In fact, company officials claim it's unnecessary. There are clearly different philosophies behind the two products. As I've often done in the past, I recommend both for the most complete approach to data recovery. It's difficult to know when one will be able to recover a cluster or sector that the other can't.

Like its competitor, *SpinRite* supports drive compression and claims full compatibility with DoubleSpace, *SuperStor* and *Stacker*. A neat trick in this version is the ability to identify a drive and even determine what parameters belong in the drive table if they're missing. That's the sort of cylinder and head information that most drive software requires you to know. Gibson *SpinRite* also works on floppies.

Rescue 4.5 from AllMicro is yet another product in the hard-drive data-recovery field. Its claim to fame is the ability to rescue data from physically damaged hard-drive platters and floppies. Of course, both *Disk Technician Gold* and *SpinRite* can do likewise in some cases. It depends on where the damage is, its extent, etc. What *Rescue* does that's different is use an alternate copy of the file allocation table (FAT) to recover data when damage to the media is in the primary FAT. It can also use the known location of clusters in other files to attempt to eliminate all but the clusters of a missing file. *Rescue* also now supports drive-compression software.

If Murphy prevails and everything that can go wrong does, you may yet end up having to reformat your drive. In this case, AllMicro also distributes *DrivePro* (from MicroHouse), a program that automatically formats and install drives. Like *SpinRite*, *DrivePro* automatically identifies drives and determines their characteristics as well.

System Documentation

Most systems come with documentation that provides all the statistics you need to maintain them. However, if you misplace this data and you don't have *SpinRite* or *DrivePro*, or if you need data for a drive that these programs don't recognize, several excellent compendiums of this information are now available as references. The most comprehensive of these references, and the broadest in scope, are the products of Micro House. All are available as hard copy in slip-cased binder sets. The *Encyclopedia of Hard Drives*, for example, is a three-part, 1,200-page reference with separate sections on setup statistics, drive jumper settings and controller configuration. The set on motherboards has five-volumes of jumpers, connections,

component locations, memory configuration, cache settings, and more.

Now both of these references, as well as the *Network Interface Technical Guide*, have been consolidated into a single online reference titled the *Micro House Technical Library on CD-ROM*. Included are the more-than-1,600 motherboards, the more than 2,100 hard drives and the hundreds of interface cards covered in the books. It makes you feel like you're in that spaghetti-sauce commercial where the guy keeps saying "It's in there" over and over. Whatever you're looking for, it's in there—at least most of the time. AllMicro sells these products, just as it does the *DrivePro* software, and MicroHouse sells AllMicro's products as well.

Windows and Unix Users

It's one of life's mysteries. Microsoft *Windows* runs on the PC. It runs under OS/2. It runs on the PowerPC under *WorkPlace* OS. It runs on the Mac (but only through special software written by Insignia Solutions Inc.—not directly, as some of the company's devious ads might lead you to believe). *Windows NT* is to run on workstations directly. Microsoft also has a version of *Windows* ready for the arrival of interactive TV. (No, not the one that already ran on television under the *Wild Palms* miniseries.) And besides *Portable Windows*, Microsoft ships a version for workgroups and another, *At Work*, for office equipment and hand-held communicators. I wouldn't be surprised if billionaire Bill even plans to run it on those greeting cards with the little music processors in them. So, why doesn't *Windows* run under Unix? Ludicrous question? Not any more.

Insignia Solutions announced that it planned to ship *SoftWindows* for Unix in December. Versions will be available for Hewlett-Packard, DEC, IBM, SGI, NeXT and Sun SPARC workstations. The company promises the performance level of a '486 on these powerful workstations. "*SoftWindows* brings the entire *Windows* environment to the Unix user with the performance that PC user's have come to expect," says Frank Cohen, Insignia's director of marketing. However, it will also eventually be possible to get the native performance level of the workstation from *SoftWindows*, because, as Mr. Cohen knows, not everyone is satisfied being a PC user. This option will work by running *Windows* applications directly under *MOTIF*.

SoftWindows is based on an entirely new technology developed by Insignia, but it also includes complete licensed copies of *Windows* 3.1 and MS-DOS. They're built right into the system to give it true compatibility with the file system, as well as such resources as serial and parallel ports. "User's will see exactly what they expect to see on Microsoft *Windows* running on a PC," Cohen avers and adds that "It can even run a software utility like *Norton Desktop for Windows*." The product provides built-in support for networks and a full range of such PC devices as floppy and CD-ROM drives, memory systems and video displays.

Insignia maintains that it has optimized actual Microsoft source code to permit *SoftWindows* to run all current and future versions of both the *Windows* environment and its applications with "100% compatibility." Cohen maintains that the alliance with Microsoft provides Insignia with "comprehensive *Windows* test suites and early versions of upcoming *Windows*' technologies, such as Object Linking and Embedding (OLE) 2.0. According to a Microsoft spokesperson, it has already been tested successfully with such recent releases as *Word* 6.0 and *Excel* 5.0.

All of this functionality is provided through an emulation of an 80286-class machine. So *Windows* will run your applications in only Standard mode. It will give you the performance of a high-end desktop machine only if you have an even higher-performance workstation like a SPARC. Nevertheless, if your intention in using a product like this is to provide *Windows* compatibility for personal-productivity applications or for accessing other types of files, it's perfect. It provides the compatibility you need without tying up any more precious desktop real estate. After all, you wouldn't really want to use this product to turn your Unix workstation into a PC, would you?.

In addition to the ability to run *Windows* 3.1 and DOS applications, product features include:

- A single installer package for all supported Unix platforms
- Complete access to all resources
- Host graphics speed and display quality
- Full support for cut, copy, paste between *Windows* applications and with host applications
- Full support for OLE and Dynamic Data Exchange (DDE) between *Windows* applications
- Full support for utilities, applets, screen savers, font managers, alternative desktops and all other programs that operate closely with *Windows*
- Support for multiple sessions for multiple applications and user mechanisms for managing MS-DOS and *Windows* application licensing Support for PC CD-ROM formats
- Support for PC networking with Novell *NetWare*, Microsoft *LAN Manager*, TCP/IP and the ODI standard.

Future releases will include support for such upcoming APIs as Win 32c. Yet another version of the ubiquitous panes. ■

Products Mentioned

Cx486DRu², $299 to $399 (Depending on Speed)
Cyrix Corp.
2703 N. Central Expwy.
Richardson, TX 75080
Tel.: 214-994-8388
CIRCLE NO. 38 ON FREE INFORMATION CARD

Kingston Technology Corp.
17600 Newhope St.
Fountain Valley, CA 92708
Tel.: 800-835-6575
CIRCLE NO. 39 ON FREE INFORMATION CARD

CPU Kooler, $39.95
PCubid Computer Technology, Inc.
6705 Silverthorne Cr.
Sacramento, CA 95842-2641
Tel.: 916-338-1338
CIRCLE NO. 40 ON FREE INFORMATION CARD

Disk Technician Gold, $149.95
Disk Technician Corp.
(Formerly Prime Solutions)
1940 Garnet Ave.
San Diego, CA 92109
Tel.: 800-847-5000
CIRCLE NO. 41 ON FREE INFORMATION CARD

SpinRite 3.1, $89
Gibson Research
35 Journey
Aliso Viejo, CA 92656
Tel.: 800-736-0637
CIRCLE NO. 42 ON FREE INFORMATION CARD

Rescue 4.5, $349; *DrivePro*, $129; *Encyclopedia of Hard Drives*, $349 (Three-Volume Set); *Hard Disk Technical Guide*, $99
AllMicro
Alan Lovell
1250 Rogers St., Ste. D
Clearwater, FL 34616
Tel: 800-653-4933 or 813-539-7283; fax 813-531-0200
CIRCLE NO. 43 ON FREE INFORMATION CARD

Encyclopedia of Hard Drives, $119.95; *Micro House Technical Library*, $599
Micro House
4900 Pearl E. Circle, Ste. 101
Boulder, CO 80301
Tel.: 800-741-3282 or 303-443-3388
CIRCLE NO. 44 ON FREE INFORMATION CARD

SoftWindows, $549 (Single User)
Insignia Solutions Inc.
1300 Charleston Rd.
Mountain View, CA 94043
Tel.: 415-694-7600
CIRCLE NO. 45 ON FREE INFORMATION CARD

By John Hastings*

Industry Watch

The AmCoEx Index of Used Computer Prices

The Clinton administration is showing continued support for the National Information Infrastructure effort. This system will ultimately be a national high-speed network for telephone, data and cable television signals. Once established, it will affect the lives of most Americans. The system will be accessible through either a home computer or a new type of interactive TV reveiver converter that will be marketed by cable and telephone companies and permit more than 500 channels of access.

Some say retailing will feel the first effect from the new system. Just as mail-order marketing eliminated much of the overhead of retail stores, the new network will permit these companies to reduce expenses further. By eliminating the cost of publishing and mailing catalogs, home shopping prices will be extremely competitive. In addition, anything that can be digitized can be delivered instantly. This includes books, movies and music. Entire libraries will be available over the network. These developments will lead to dramatic changes in our educational system as well.

On another subject, Intel is expected to announce a 100-MHz version of its 486 CPU chip. This move may be necessary as a result of problems plaguing the company's more-powerful Pentium chip. The most-recent problems with the Pentium prevent it from running in its fastest mode. Meanwhile, many of the chips continue to experience overheating problems. Intel hopes to cure all of these problems with new versions of the Pentium chip. However, these new chips may not reach the market until spring. Motorola feels this delay offers a window of opportunity. It hopes to establish its PowerPC chip as the most-dependable high-end processor.

Prices of new and used 486 computers may soon be forced lower as a result of greater competition in the 486 CPU chip market. Texas Instruments announced it will soon begin

Table 1. Market Details of Used Computer Equipment as of November 2, 1993

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change
IBM PS/2 Model 30/286 20M	$300	$525	$375	+$25
IBM PS/2 Model 50Z 30M	300	650	425	+25
IBM PS/2 Model 70 120M	600	900	725	-50
IBM PS/2 Model 80 70M	550	850	625	+25
IBM ThinkPad300	1,250	1,650	1,300	-75
IBM ThinkPad700	2,100	2,700	2,100	-100
AST 286/12, 40M	275	675	350	—
AST 386/20, 80M	550	950	700	-25
Dell 325SX, 50M	400	800	625	-75
Dell 386/20, 120M	600	1,000	725	-100
Gateway 286/16, 40M	350	600	325	-50
Gateway 386SX/20, 80M	600	950	675	—
Gateway 386/25, 80M	600	1,000	850	+100
Clone AT 40 M	250	550	350	—
Clone Notebook 286, 40 M	350	750	600	—
Clone Notebook 386SX, 40M	500	1,050	800	+75
Clone 386/SX 40M, VGA	450	950	650	+50
Clone 386/25 80M, VGA	650	1,150	725	—
Clone 386/33 80M, VGA	750	1,250	850	+25
Clone 486/25 120M, VGA	800	1,450	1,000	—
Compaq SLT/286 20M	400	800	425	+25
Compaq LTE 286 40M	400	775	475	-25
Compaq Portable III 40M	250	650	275	-100
Compaq Deskpro 286 40M	250	650	300	88
Compaq Deskpro386/20e 100M	600	900	800	+25
Macintosh SE 20M	350	650	425	-100
Macintosh SE/30 40M	600	900	650	-50
Macintosh II 40M	600	1,150	775	-50
Macintosh IIcx 80M	800	1,300	875	-50
Macintosh IIci 80M	1,200	1,600	1,250	-175
PowerBook 100 4/20	700	1,100	700	-100
PowerBook 140 4/40	900	1,400	1,075	-25
PowerBook 170 4/40	1,100	1,700	1,400	+75
LaserWriter IINT	700	1,300	800	-75
Toshiba 1200XE	300	650	325	-50
Toshiba 1600	300	700	325	-25
Toshiba 2200 SX 60M	800	1,300	925	+100
Toshiba T-3100SX 100M	500	900	725	+125
Toshiba 5200 100M	900	1,400	1,100	-125
HP LaserJet II	400	850	650	—
HP LaserJet IIP	325	950	500	-75
HP LaserJet III	750	1,200	1,000	-25

*John Hastings is the president of the American Computer Exchange Corp., which matches buyers and sellers of used microcomputer equipment. For more information, call the American Computer Exchange Corp. at 800-786-0717.

marketing it own version of the chip. It will join AMD and Cyrix in challenging Intel, which has the lion's share of the market. Meanwhile, sales of Intel's 586-generation Pentium chip haven't met expectations. Intel claims most computer makers haven't done the necessary research to support the new chip. Consequently, Intel announced that it will begin manufacturing complete systems. It estimates that 25% of its new chips will go into its own systems. Many computer makers view this as unwanted competition from their primary supplier. Some are expected to retaliate by developing systems using Motorola's new PowerPC chip.

While several manufacturers have marketed 486 CPU chip upgrades for 386 computers, Improve Technologies of Provo, UT, introduced a 486 upgrade for older 286 computers. A spokesman for the company said the chip would run at twice the speed of the original 286 CPU chip and provide approximately four times the performance. More importantly, the upgrade permits the computer to run all of the latest software. With a suggested list price of $299, this product could increase the demand and prices of older 286 computers in the used-equipment marketplace. Each October, Apple Computer announces several new models of the Macintosh computer. This year should be no exception. The model expected to have the greatest impact on the used market will be the Quadra 605. This 25-MHz 68040 computer is expected to sell for less than $1,300 with a color video monitor.

Demand for some older Macintosh computers is dropping, partly due to their lack of a high-density floppy-drives. Apple hasn't sold a computer with the old 800K floppy drive for the past four years. While the newer 1.44M drives can read the older 800K disks, this situation may soon change. New computers from Apple may read only 1.44M- and 720K-formatted disks. This small change could reduce demand and prices for many older Macintosh computers.

Prices of some new and most used laser printers may fall soon when Sharp Electronics debuts its JX-9460-PS printer. The six-page-per-minute printer is 50% faster than most personal laser printers in its price range.

Table 2. Market Details of Used Computers as of December 1, 1993

Machine	Average Bid	Average Buyer's Ask	Seller's Close	Change
IBM PS/2 Model 30/286 20M	$300	$525	$325	-$50
IBM PS/2 Model 50Z 30M	300	650	350	-75
IBM PS/2 Model 70 120M	600	900	600	-125
IBM PS/2 Model 80 70M	550	850	575	-50
IBM ThinkPad300	1,250	1,650	1,200	-100
IBM ThinkPad700	2,100	2,700	1,950	-150
AST 286/12, 40M	275	675	325	-25
AST 386/20, 80M	550	950	625	-75
Dell 325SX, 50M	400	800	575	-50
Dell 386/20, 120M	600	1,000	650	-75
Gateway 286/16, 40M	350	600	325	—
Gateway 386SX/20, 80M	600	950	625	-50
Gateway 386/25, 80M	600	1,000	700	-150
Clone AT 40 M	250	550	325	-25
Clone Notebook 286, 40 M	350	750	500	-100
Clone Notebook 386SX, 40M	500	1,050	700	-100
Clone 386/SX 40M, VGA	450	950	600	-50
Clone 386/25 80M, VGA	650	1,150	650	-75
Clone 386/33 80M, VGA	750	1,250	750	-100
Clone 486/25 120M, VGA	800	1,450	900	-100
Compaq SLT/286 20M	400	800	350	-75
Compaq LTE 286 40M	400	775	500	+25
Compaq Portable III 40M	250	650	275	—
Compaq Deskpro 286 40M	250	650	300	—
Compaq Deskpro386/20e 100M	600	900	700	-100
Macintosh SE 20M	350	650	400	-25
Macintosh SE/30 40M	600	900	550	-100
Macintosh II 40M	600	1,150	600	-175
Macintosh IIcx 80M	800	1,300	725	-150
Macintosh IIci 80M	1,200	1,600	1,000	-250
PowerBook 100 4/20	700	1,100	700	—
PowerBook 140 4/40	900	1,400	1,000	-75
PowerBook 170 4/40	1,100	1,700	1,475	+75
LaserWriter IINT	700	1,300	750	-50
Toshiba 1200XE	300	650	350	+25
Toshiba 1600	300	700	300	-25
Toshiba 2200 SX 60M	800	1,300	875	-50
Toshiba T-3100SX 100M	500	900	600	-125
Toshiba 5200 100M	900	1,400	1,050	-50
HP LaserJet II	400	850	625	-25
HP LaserJet IIP	325	950	475	-25
HP LaserJet III	750	1,200	900	-100

The high-resolution 600-dot-per-inch printer is expected to have a street price under $700. This is several hundred dollars less than any other PostScript printer on the market. A comparable Hewlett-Packard laser printer sells for almost twice this amount. An eight-page-per-minute model of the Sharp printer, the JX-9660PS, is expected to sell for less than $900.

IBM and Motorola have combined forces to produce a new family of CPU chips to challenge Intel's dominance in that field. The first PowerPC CPU chip is designated the 601. This chip delivers 586-class performance at half the price of Intel's Pentium chip. The Pentium chip, which sells for over $900, is expected to drop to less than $500 by spring. Meanwhile, the second generation PowerPC 603 is ready for introduction. While it isn't as powerful as the 601, the 603 is smaller, uses less power and is expected to sell for less than $225.

Low power requirements of the 603 chip make it make it an ideal high-performance CPU for notebook com-

puters. Intel's current Pentium isn't feasible for portable computers because it runs too hot and consumes too much power. It's not likely to be seen in a notebook computer until 1995, when smaller, cooler versions of the chip will be produced. In the meantime, Dolch Computers is ready to announce its PAC-586 luggable computer that uses the existing version of the Pentium. The computer weighs more than 20 pounds and uses a special liquid cooling system. With a price of more than $6,000, it should have little effect on the portable market.

IBM is expected to soon announce a notebook computer that uses the new PowerPC chip. The new notebook computer may be the first IBM product to include a built-in connector for AppleTalk, the network used with Macintosh computers. The new computers are expected to run software for DOS, *Windows*, OS/2 and the Macintosh. When new Macintosh computers are announced this year, they'll use the new PowerPC CPU chip. It's expected that these new systems will run both Macintosh and *Windows* software. To accomplish the same thing with today's computers, Apple announced in december 1993 a new option for some of its computers that includes an 80486 CPU chip and VGA graphics. For a few hundred dollars more, users can access almost any software on one computer. A single keystroke will allow them to switch between Macintosh and *Windows* applications.

The lines of distinction between Apple and IBM will continue to blur this year. The two companies are working together on a new operating system called *Taligent*. Both companies will have a complete line of computers that use the PowerPC CPU chip. Both companies appear to be contracting with Samsung to manufacture those computers. The two companies seem to have more similarities than differences.

Prices of used Macintosh computers continued to fall in December 1993, following Apple's announcement of its revamped product line. In addition, many dealers need to clear inventories of some older models. For example some dealers are advertising the 25-MHz Macintosh LC III with a color monitor for less than $1,000.

If Apple Computer can meet the demand for the new Quadra 605 computer, prices of used Macintosh computers will fall at unprecedented rates. This is the first Macintosh computer that can outperform most comparably priced 486-based PC's. It runs at four times the speed of a Mac IIci and sells for less than $1,000. An avalanche of used Mac IIs and Mac LCs are entering the used market as most users feel this is the time to upgrade. While demand for these systems is falling, the supply is exploding. Prices in the used market may tumble unless Apple has trouble meeting the demand for the new computer. Even if this occurs, the delay will be temporary.

In 1992, Compaq Computer's board of directors ousted its chief executive and placed a strict German in charge of the company, who slashed prices, brought in a new line of low-cost computers and increased market share and profits. Today, the company is one of the most-profitable in the industry. Apple Computer is hoping its situation will seem like "deja vu all over again." In a remarkably similar scenario, Apple is changing top management and cutting prices in hopes of revitalizing the company. For the first time, some Apple computers are priced as low as or lower than low-priced Compaqs of comparable power. For many small businesses that need to network groups of computers, this is an incredible bargain because every Macintosh includes built-in networking hardware and software at no extra cost.

Prices of high-speed modems are falling as manufacturers prepare new models for the market. Until recently, modems that communicated at 14,400 bits per second were considered high speed. Within a few moths, the new standard will be 28,800 bps. To clear inventory, most makers are cutting prices by 20% to 40%.

Personal Digital Assistants, or PDAs, like the Apple Newton, rely on handwriting recognition for data entry. New versions of PDAs due out this year may utilize voice recognition for input. Some makers are considering a combination of voice and handwritten input.

Prices given in Table 1 are for November 2, 1993. Those in Table 2 are for December 1, 1993. ■

several popular PCMCIA notebooks, such as Toshiba's 3300SL, don't adhere to the ExCA specification. Adherence to the ExCA specification by a card interface supposedly guarantees that any PCMCIA Card will work with this interface.

• ***Type I and II Extended Cards.*** Extended cards are PCMCIA-recommended extensions to the PCMCIA Type I and II Card types. Extended cards are identical to regular cards, except that they're 50 mm longer. These form factors were primarily specified so that designers and manufacturers of I/O PC Cards could encase their electrical- and magnetic-isolation devices within the shield PC Card enclosure. Figure C shows a Type I extended card.

• ***Hot Card Insertion/Removal.*** The PCMCIA standard takes advantage of the fact that certain peripherals, such as fax cards, aren't needed at all times. Hot swapping lets you unplug one and plug in another PC Card, without having to off turn power and then turn it back on or reboot your system. Data integrity must be protected when a PC Card is plugged into or removed from a slot while the system is powered up. To resolve this issue, PCMCIA adopted a design that uses different-length contact pins in the connector. The longest pins conduct power and ground to ensure that data and disconnect signals disengage first to preserve data integrity.

• ***Other PC Card Features.*** Other features of PC Cards include dual-voltage operation, host independence and high performance. Dual-voltage operation permits designers to build a PC Card that drops the system to 3.3-volt operation (in contrast to standard 5-volt operation) to save battery power and extend useful battery life.

Host independence means that PC Cards can be designed to run with any host machine that has a PCMCIA interface, regardless of the host's processor or operating system. Theoretically, the same PC Card could run on an IBM PC/compatible notebook, an Apple Newton PDA (personal data assistant), a pen-based computer, an AT&T Personal Communicator and a digital camera. This flexibility isn't mandatory, and different software would have to be provided to handle different hosts.

As for performance, PCMCIA Release 2.0 added I/O and interrupt structure that permits PC Cards to be used as high-speed I/O devices, such as local-area-network (LAN) adapters. Existing PCMCIA Ethernet adapters exhibit performance that's comparable to the internal bus adapters commonly used in file servers, engineering workstations and desktop PCs.

PCMCIA Ethernet adapters can dramatically outperform external adapters based on parallel ports. I/O devices that can take advantage of PCMCIA's high performance include wireless LAN adapters, Token Ring adapters, SCSI ports, micro disk drives and solid-state disk emulators.

PCMCIA and the PC Bus

To implement a PCMCIA interface in a PC, designers use either a single-chip PC with a built-in PCMCIA interface or a host adapter IC. Single-chip PCs that have PCMCIA support have appeal for portable applications. For example, Vadem's (San Jose, CA) VG-230 contains an 8086-compatible CPU and an interface to a single PCMCIA slot that can accommodate either memory or I/O cards (PCMCIA 2.0). Also, Chips and Technologies' (San Jose, CA) 8680 PC chip, an 8086-compatible CPU, has an interface to a single PCMCIA slot. The 8680's interface handles only memory cards (PCMCIA 1.0), but an updated 8680A chip includes PCMCIA 2.0 capabilities.

Host Adapter ICs provide an interface

PCMCIA falls somewhat short of the versatility and ease-of-use criteria expected in a standard PC.

Unlike the AT and EISA slots in a desktop PC, which have had eight years in which to have their kinks ironed out, the PCMCIA industry is still trying to find its rhythm—much like a freshman football squad that knows the rules of the game but hasn't yet honed its skills. This leads to compatibility problems. For example, a modem card that works in a Toshiba T4600 color notebook may work only marginally in a Zenith Z-Lite and not at all in Toshiba's T1950TS Satellite notebook. In fact, this was the case with Intel's Faxmodem 96/96.

All the notebooks I tested experienced trouble with one or more PCMCIA cards, and a few had no success at all at running the most-compatible PCMCIA cards. Yet they did a fine job with a couple cards other systems completely rejected.

On the other side of the coin, not a single card tested would work in all systems. In fact, at least one, Fujitsu's 1M Flash Card, failed in every system tested. At the other extreme, Epson's Fax/Modem Card, Compaq's PCMCIA 14.4 Data + Fax Modem and AT&T's KeepInTouch Card worked in all but one system—the Gateway ColorBook.

Software is the Key

Surprisingly, spotty compatibility is consistent with PCMCIA. Virtually all the blame can be placed on the software drivers that are supposed to create the transparent link between PCMCIA and the PC's BIOS.

There are basically two factors that control how a PCMCIA card is recognized and utilized. One is the Card Socket Services software (CSS), which is either incorporated in the notebook's BIOS or is loaded as a TSR device driver. The other is the set of drivers included for specific PCMCIA card functions. For example, the driver used for Flash memory won't work with a rotating-platter hard-disk card. You must have a separate driver for each. Since there are hundreds of PC Cards on the market, with more arriving daily, no one vendor provides all the required drivers. For instance, SystemSoft of Natick, MA, a leading supplier of drivers that has about a dozen general drivers for different types of PCMCIA devices (including 17 different types of Ethernet cards), falls short of the mark.

Moreover, system vendors don't buy all the drivers they should. Most buy modem and hard-disk drivers, but few buy ethernet drivers. So even though solutions may exist, they might not end up in your hands. Ideally, they should be supplied or made available by the computer system manufacturer when you buy your notebook or desktop PCMCIA drive. But if you need a driver that isn't provided, you're in trouble. Even when the PCMCIA card vendor ships the required drivers with the card, there's no guarantee they'll work with your PC's version of Socket and Services software.

Current versions of the PCMCIA software are marketed by a handful of manufacturers, including AMI, Award, Databook, Phoenix, SystemSoft and VMI. All differ in significant ways. If you had all the available drivers from a single source, as you find in *CorelSCSI!,* compatibility might not be an issue. The best guide to compatibility

between a PC bus and one or more PCMCIA sockets. In conjunction with system software, these adapters handle most of the details of power management, hot insertion and removal, memory mapping, I/O mapping and interrupt steering. In addition, for card-socket pins that take on different meanings for memory and I/O cards, the adapters provide connections to the appropriate signals.

All the manufacturers of host-adapter chips claim compatibility with Intel's ExCA specification. Most chips are also compatible with Intel's 83265 host adapter ICs.

Vendors of host adapter ICs that go beyond ExCA claim both Step A and Step B register compatibility with Intel's adapters. Step A corresponds to Intel's original 82365SL adapter, while Step B corresponds to the more-recent 82365SL DF, which adds power-management features.

No matter how a designer implements a PCMCIA interface in hardware, few of PCMCIA's ease-of-use features are available, unless some powerful host-system software is added as well. Both Socket Services and Card Services are available from companies that sell PCMCIA system software, including SystemSoft, Phoenix, AMI, Award, Databook and Ventura Micro.

PC Card ATA Standard

ATA (AT Attachment) is the dominant standard for disk drives in mobile computers. This standard wasn't developed by PCMCIA, but by CBEMA (Computer and Business Equipment Manufacturer's Association). The PC Card ATA standard describes how the ATA protocol maps onto the PCMCIA interface. It resolves and clarifies the enhancements and restrictions that result from use of the PCMCIA interface with the ATA protocol. Mass-storage peripherals, such as the Flashdisks manufactured by SunDisk (Santa Clara, CA), are PCMCIA ATA-compatible.

PC Card Applications

PC Card applications include memory cards, fax/modems, hard-disk drives, LAN adapters and other kinds of peripherals. Most are more expensive that their ISA-bus counterparts. Some applications, however, are unique to PCMCIA. Flash cards and multiple-application cards are two examples.

Current PCMCIA flash-memory cards store up to 40M of data on a single card. In some cases, flash cards can mimic hard disks. However, at prices that hover around the $3,000 mark, flash cards aren't likely to replace hard disks in the near future.

A multiple-application card is a PC Card that can hold up to 12 ROM chips called "tokens." Users can insert tokens by lifting a plastic lid on the card and popping the chips into place. When the lid is closed, the card can be plugged into a PCMCIA slot. With this kind of card, software companies can publish their applications on tokens, rather than on disks, instead of using a separate PC Card for each application.

These and other applications show the promise of the PCMCIA standard. A product like the flash-memory PC Card may eventually replace the ubiquitous hard-disk drive, and ISA-bus expansion cards may be replaced by easy-to-install PC Cards as soon as PCMCIA sockets begin appearing on desktop PCs. Whatever occurs in the future, PC Cards have already become indispensable products for notebooks, sub-notebooks, PDAs and any other devices that currently contain PCMCIA slots. ■

is the notebook manufacturer's PCMCIA "recommended" or "approved" list. But being on a recommended list is no guarantee of success.

PCMCIA Matchmaker

Is PCMCIA for you? Unfortunately, until the market matures, you have to take it on a notebook-by-notebook/card-by-card basis. Installing a PCMCIA card can be as easy as falling off a log if you make the right choice. So what is the right choice? Simply make sure that the PCMCIA card you want to use is supported by your system. With all the new software coming on the market, this shouldn't be too great a problem. But buying extra software to make up for initial shortcomings is a bummer.

Still, PCMCIA is a big step in the right direction. As use of PCMCIA increases, prices will drop. As it stands at the present time, PCMCIA fax/modem cards cost little more than external fax/modems, and PCMCIA SCSI and Ethernet cards cost just as much as their ISA equivalents with the same features.

The ability to customize a PC by simply plugging in a card or two is what the inventors of the original home/business PC envisioned. PCMCIA brings this concept closer to reality. ■

PCMCIA Glossary

Card Services. A software layer that manages multiple clients and the PC cards, sockets and system resources available for the cards.
CITE Card Information Structure (CIS). A data structure written at the beginning of a card that describes formatting and data organization on the card.
Compression. Encodes data so that it takes up less space when stored. It's a common ploy used to increase the size of both solid-state and rotating-platter PCMCIA hard disks.
Ethernet. A local-area network (LAN) that transmits data over telephone or coaxial cable at speeds up to 10M bits/s. Up to 1,024 nodes can be connected.
File-Allocation Table (FAT). A table that DOS uses to record disk sectors currently used to store files.
FFS2. Microsoft's Flash File System (Version 2) enables Flash memory cards to be treated like a DOS-compatible disk drive. All DOS commands work with FFS2-formatted cards, with the exception of CHKDSK and FORMAT. DOS can't be booted from an FFS2-formatted Flash card.
Flash Memory. A PC memory card that contains erasable programmable read-only memory (EEPROM) that holds its contents without the need for power but must be erased in bulk. Typically, Flash memory is very fast for read access and is generally used for read-only applications because the memory device wears out after about 10,000 write/erase cycles.
Hot Swaps, Quick Swaps. The ability to plug and unplug PCMCIA cards without having to shut down system power.
OTP. A type of programmable read-only-memory device (ROM) that can be programmed only once. OTP stands for one-time programmable.
PC Card. Any memory or I/O peripheral card that complies with PCMCIA standards.
PCMCIA. Personal Computer Memory Card International Association, a non-profit trade and standards association that establishes and maintains the PCMCIA specifications.
Plug and Play. The emerging concept that nearly any PCMCIA card should function in virtually any PCMCIA-slot-equipped system without undue grief.
Socket Services. The standardized fundamental software connection between PCMCIA cards and applications software.
SRAM. Static memory chips that require power to maintain their data. Although faster than dynamic RAM (DRAM), they're more costly and use more power than Flash memory.

SuperMart

This new advertising section highlights products in an easy-to-locate format for reader convenience. Call Margaret Milanese today for deadlines and additional details at 516-681-2922 (FAX 516-681-2926).

EPROM+
PROGRAMMING SYSTEM USES PARALLEL PORT

SUPPORTS OVER 500 CHIPS

•*EPROMS* (24,28,32 & 40*PIN + 27C & 28F) 2708,16,32,32A,64,64A,128,128A,256,512,513,011 010,101,1001,1000,1024,2,210,020,2001,220,2048 4001,040,240, 2516,2532,2564,68764/66,TMS2716
•*EEPROMS* (24 & 28 PIN PLUS 28CXX) 2804,2816,2816A,2718,2864,2864A,2865,28256
•*SERIAL EEPROMS** (8 PIN PLUS CXX) 9306/46/56/66,2444,2401/02/04,85XX,ER1400
•*BIPOLAR PROMS* * 74SXXX, 82SXXX
•*MICRO CONTROLLERS* * 8741,42,48,49,8751 87C5X,87C751/752,68705,68HC705,TMS7742
* ADAPTER REQUIRED - DIAGRAMS INCLUDED

•SOFTWARE - READ, VERIFY, PROGRAM, COPY, DISK FILE LOAD & SAVE CHECKSUM, BUFFER EDITOR W/ 20 COMMANDS, HEX & BINARY FILES
•FAST! - MOST DEVICES PROGRAM IN UNDER 60 SECONDS
•RUGGED (8" X 7" X 3"), PORTABLE ENCLOSURE WITH CARRY HANDLE
•MADE IN THE U.S.A. - 10 DAY MONEY BACK GUARANTEE -1 YR. WARRANTY
•SYSTEM INCLUDES: UNIT, POWER PACK, CABLE, MANUAL & SOFTWARE

ANDROMEDA RESEARCH
P.O. BOX 222
MILFORD, OHIO 45150
(513)831-9708 FAX (513)831-7562

$289
ADD $5.00 SHIPPING $5.00 C.O.D.
VISA/MASTERCARD

CIRCLE NO. 57 ON FREE INFORMATION CARD

AFFORDABLE ENGINEERING HARDWARE / SOFTWARE

Engineering Software - PC-MSDOS

• Electronic Circuit Design	$ 49
• Schematic Drawing Program	$ 49
• PCB Design & Circuit Drawing	$169
• PC-SCOPE Oscilloscope	$ 49

PC Bus Plug-In Cards

• 24 Bit TTL I/O, 48 Bit TTL I/O	$39, 49
• 12 Bit Data Acquisition & TTL I/O	$ 89
• 16 Bit Counters & TTL I/O	$ 89

- More Hardware & Software is available -

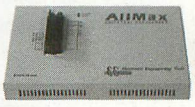
Call or Write for FREE Catalog

BSOFT Software, Inc.
444 Colton Road
Columbus, OH 43207
(614) 491-0832
Fax (614) 497-9971

CIRCLE NO. 58 ON FREE INFORMATION CARD

NEW AllMax
UNIVERSAL PROGRAMMER

AllMax $645



- **Programs** PAL, GAL, EPLD, PEEL, E(E)PROM & Flash (up to 16 bit), Bipolar-PROM, MICROS (87xx, PIC 16/17, COPxx, Z86xx, PSD3xx)
- **Tests** TTL/CMOS, DRAM/SRAM
- Supports Standard **48-pin Gold-ZIF** Socket
- Optional Adapter for **Printer Port** (**AM-PRT: $185** Includes Transformer)
- **LIFETIME FREE UPDATES VIA B.B.S.** (408-734-8945)
- **2 YEAR WARRANTY, MADE IN U.S.A.**

EE Tools Inc. *408-734-8184, 8185 (FAX)*
528 Weddell Dr. #3, Sunnyvale, CA 94089

CIRCLE NO. 62 ON FREE INFORMATION CARD

Automatic Model Maker!

9x5x6.5 - The Cub even cuts lt. steel! Perfect for small parts manuf., engraving & model making.

3-D CAD-CAM

Power packed BOBCAD-CAM loaded with time saving features is the preferred choice in the industry. Automatic fillets, pocketing, nesting, 1000x zoom, verity data, machinable fonts, Autocad™ interface, calculator, tool path simulation, cutter compensation, macros, editing functions - are just a few of the many features available. Used on all types of G-code machines it also posts to the Indexer-LPT directly.

ONLY $995.00

BOBCAD - CONTROLS
800-501-2886 310 397-6262 310 397-6676 (FAX)

CIRCLE NO. 89 ON FREE INFORMATION CARD

RACK AND CHASSIS BOXES

RACK CHASSIS

MODEL	DESCRIPTION W x D x H (inches)	PRICE $
1RU5	19 x 5 x 1.75	30.85
1RU7	19 x 7 x 1.75	33.10
1RU10	19 x 10 x 1.75	35.25
2RU5	19 x 5 x 3.5	33.10
2RU7	19 x 7 x 3.5	35.25
2RU10	19 x 10 x 3.5	37.50
3RU5	19 x 5 x 5.25	41.90
3RU7	19 x 7 x 5.25	44.10
3RU10	19 x 10 x 5.25	46.30

METAL CABINETS

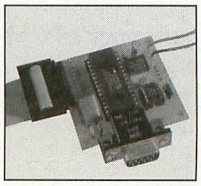
MODEL	DESCRIPTION W x D x H (in.)	PRICE $
MC-1A	4 x 3 x 2	16.50
MC-2A	6 x 3 x 2	18.75
MC-3A	8 x 3 x 2	20.95
MC-4A	4 x 4 x 3	18.75
MC-5A	6 x 4 x 3	20.95
MC-6A	8 x 4 x 3	23.15
MC-7A	4 x 7 x 4	20.95
MC-8A	6 x 7 x 4	23.15
MC-9A	8 x 7 x 4	25.75

IN STOCK FOR IMMEDIATE DELIVERY

USA AND CANADA ORDERS (800) 634-3457
FAX ORDERS (800) 551-2749
SESCOM, INC., 2100 WARD DRIVE
HENDERSON, NEVADA 89015 USA
TECHNICAL HELP (702) 565-3400

VISA AND MC ORDERS SHIPPED GROUND AT NO CHARGE (48 STATES)

CIRCLE NO. 80 ON FREE INFORMATION CARD



ROBOMASTER CONTROLLER

This is the fast NEW PIC 16C55 RISC running at 20 MHz and 16 I/O IN/OUT lines and 2 strobes. Control it from any serial port at 9600 baud version or 115,200 baud version. With the 9 pin serial you can control anything you can think of A/D, D/A, ROBOTICS, ALARMS, SENSORS, REMOTE MODEM APP's. Use our preburned 16C55 I/O chip or the 16 model airplane servos real time chip, all chips use EZ4 or EZ16 COMMANDS. Board and one of these chips $89.95 or W/O chip $59.95 + $5.00 S/H Demo software Examples included.

SEND CHECK or MONEY ORDERS to
P.C. PORTER,
P.O. BOX 732, Titusville, FL 32781-0732
(407) 268-4562 EST.

CIRCLE NO. 74 ON FREE INFORMATION CARD

Trans PC 5.0

Trans PC 5.0 is the utility for an instant, error-free transfer and management of files between PCs. It transfers data over parallel printer ports utilizing patented Write-Back-Engine technology of signal processing. It guarantees highest reliability of a transfer over 400 ft. Trans PC runs on any PC under DOS< as a Command Line Processor, or point-and-shoot GUI. It supports all types of drives, automation, transfer between multiple PCs and multitasking under DESQview. According to John C. Dvorak from PC Magazine: "It's a marvel, pretty phenomenal, unquestionably the fastest. Package contains 5 1/4 and 3 1/2 inch diskettes, 10 feet (3.0 m) Trans Cable, Trans Reference and User's Manual. Retail Price is US $179.

Special trial offer $49.

AUTODESK REGISTERED DEVELOPER

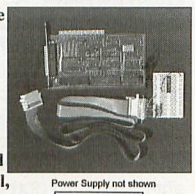
Trans Digital CORPORATION
37300 Central Court
Newark CA 94560
Tel: (510) 745-9777
Fax: (510) 745-9936

CIRCLE NO. 84 ON FREE INFORMATION CARD

Actual Circuit Emulation
A better way than ICE!

- More power with much less cost
- Drivers for LCD,DTMF,more
- External power supply for 24 hour a day operation
- Runs independently of PC
- Versatile Interface Adapter on eBoard, simple expansion
- Board resident Forth option
- Use as programmable PCcard
- All source is included. Kernal, Forth. PC Debugger and Assembler
- Cable, Breadboard, Power supply

The eBoard™



Power Supply not shown

$195.95
This is a limited time price for the 6502, 6522 version. Includes shipping and handling

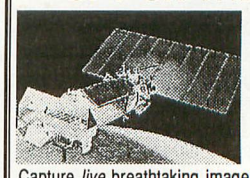
Highlands Electronics
13720 LakeShore Drive
ClearLake, CA 95423
Phone 707 994-1024
Fax 707 994-5823

MasterCard Visa

Object Oriented Hardware™

CIRCLE NO. 63 ON FREE INFORMATION CARD

SPY ON THE EARTH



See *live* on your PC what satellites in orbit see

Capture *live* breathtaking images of the Earth for fun or profit. Zoom in up to 20X. Send $39 check or M.O. ($45 air, $50 overseas) for our *fantastic* 12 diskette set of professional quality copyrighted programs (IBM type) that does satellite tracking, image acquisition, image processing, 3-D projections and more. Direct reception from the satellites guaranteed worldwide without a satellite dish. Schematics included for interface. For FREE information log-on to our bulletin board anytime at: (718) 740-3911.

VANGUARD Electronic Labs
Dept. C, 196-23 Jamaica Ave.
Hollis, NY 11423 Tel.718-468-2720

MicroComputer JOURNAL

Microcomputer Q & A

(from page 88)

A. It's a driver supplied free of charge by Microsoft. This driver lets your PC's speaker work like a sound card, when properly configured. Just download the file SPEAK.EXE from the Microsoft Product Support Download Service at 206-936-6735. SPEAK.EXE is also available on America OnLine and CompuServe. If you don't have a modem, you can get the complete driver library for $20 by calling Microsoft Sales and Service at 800-426-9400.

Copy SPEAK.EXE to an empty directory or floppy and decompress it by typing SPEAK at the DOS prompt. This explodes it into six files that includes installation instructions. To add it to *Windows*, all you do is open the Control Panel from the Main menu and choose the Drivers option. Highlight Unlisted Updated Driver from the list of driver options, then click on Add. Type in the path of the speaker file or floppy, and select Sound Driver for PC-Speaker. Unfortunately, the driver doesn't work with all PCs and may cause problems with communication programs, multimedia packages or other timing-sensitive applications. And sound quality is only as good your PC's speaker—some of which are pretty "tinny"-sounding. But you do get free sound that's acceptable for a lot of *Windows* applications. ■

Are You Moving? Let us know.

Mail your subscription label along with your new address, to us, so you can be sure you don't miss a single issue.

Letters *(from page 7)*

because of what it has to offer, and now I'm wondering about just what's going to show up on my doorstep next month. Your editorial did mention some areas that will be covered in the new magazine, but I find myself craving details. I suppose I'd better wait for the next issue to arrive before commenting heavily. I just hope *MicroComputer Journal* doesn't turn into a magazine of semi-technical fluff aimed at the not-so-technical MIS manager and be three-quarters advertising and one-quarter boring software and hardware reviews like 99% of the other computer magazines on newsstand displays.

Of course, if your past performance is an indicator of what this new magazine will be like, I'm sure it will be as successful as *ComputerCraft* was.

Doug Wright
Scarboro, Ontario, Canada

Have no fear! The articles and departments in MicroComputer Journal *are currently and will continue to be basically the same as you've been reading in* ComputerCraft. *The changes we've made are basically minor, such as the dropping of the "Computer Games" column and addition of "Multimedia" and "Computing On the Go" columns. The one major change is our frequency of publication, which is now six times a year (as opposed to* ComputerCraft*'s 12 times a year), with a greater number of pages per issue.—Ed.*

Corrections

- As a result of a computer mix-up, the schematic diagram shown as Fig. 3 in Jan Axelson's "Wireless Links, Part 3" article in the November 1993 issue of Computer-Craft was a repeat of the Fig. 4 schematic in the same article. The schematic shown here is the correct one for Fig. 3.
- The street address given for BSoft Software in the ad on page 108 of the January/February issue is incorrect. It should read 444 Colton Road.

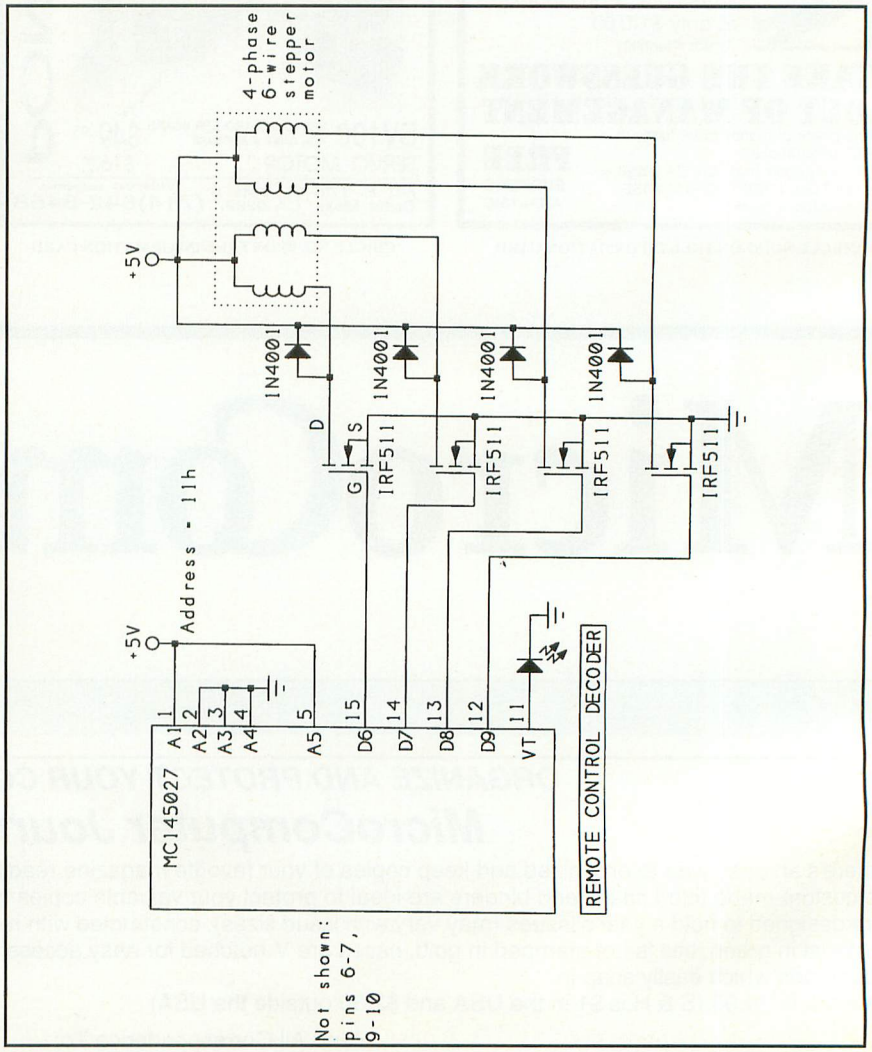


Figure 3.

Classified Commercial Rates: $1 per word, 15-word minimum ($15.00) prepaid. (Word count includes name and address; ZIP code and abbreviation each count as one word; P.O. Box number and telephone number count as two words each.) Indicate free category heading (Computers, Software, Electronics, Video or Miscellaneous). A special heading is available for a $6 surcharge. First word only is set boldface caps at no charge. Add 25¢ for each additional boldface word.

Non-Commercial Rates: FREE to subscribers, as space permits; maximum 15 words. A recent MicroComputer Journal mailing label must accompany ad.

(All advertisers with P.O. Box addresses must supply permanent address and telephone number. Copy is subject to publisher approval.)

Mailing Information: Copy must be received by the publisher by the 25th of the third month preceding the cover date. Send Advertising material with check or money order or credit card information (Visa or MasterCard only) with number and expiration date to: **MicroComputer Journal, Classified Department, 76 N. Broadway, Hicksville, NY 11801.**

BUSINESS OPPORTUNITIES

$1000.00 weekly using your personal computer! Begin now. Rush S.A.S.E.: Zellers, 1001(C) East Maple Street, Lebanon, PA 17046.

ENTREPRENEUR'S HOTLINE BBS! Money-Making Reports, Email Technical Assistance, Specialized Files, Online Chat, Post Ads, Free Look! BBS# 206-678-4033.

MAKE $75,000/YEAR cleaning computers part time! Through video/book training course. FREE Information. ML Productions, Carbondale, Colorado. Call (303) 963-1316 Dept. CC-2

MAKE $90/HR as an Independent Computer Technician. Secrets revealed by successful computer store owner. FREE information. ML Productions, Carbondale, Colorado. Call (303)963-1316 Dept. CC-3.

CABLE TV

CABLE TEST CHIPS. Jerrold, Tocom, S.A., Zenith. Puts cable boxes into full service mode! $29.95 to $59.95. 1-800-452-7090,(310)902-0841.

EARN BIG commissions selling our drug awareness software to schools, stores, parents, etc.! It's **HOT** and in demand! Free info, or $1 for our disk newsletter. Opportunities Online Dept. CC POB 3403 Wichita Falls, TX 76301.

COMPUTERS

MAGAZINE supporting Z80, CP/M, S100, Kaypro, 8031, 6809 and more. **The Computer Journal.** 10th year of classic computer projects. Hardware, software, Forth, assembler. Micro-C Kaypro disks and schematics. 6 issues, $24, Free sample. (800) 424-8825. TCJ, P.O. Box 535, Lincoln, CA 95648

MICROCONTROLLERS MCB8031: 32k RAM/ROM, 14 LINES I/O, RS232, $79. MCB8052: 8k/32k RAM, 8k/16k ROM, 4 DECODED OUTPUTS, 24 LINES I/O, PROGRAMS EPROMS, EEPROMS, AND NVRAM, RS232, $109. TO ORDER SEND CHECK OR MONEY ORDER PLUS $5 S/H TO: BLUE RIDGE MICROS, 2505 PLYMOUTH ROAD, JOHNSON CITY, TN. 37601. FAX (615) 929-3164, PH. (615) 335-6696.

COMPUTER KITS: We have close out items at discount prices. Bareboards (BB), kits (KT), system monitor EPROMs (ME), BASIC interpreter EPROMs (BE), and PC based cross assemblers (CA). Hardware includes manual with schematics. Kits include all parts and chips, less software. 8031-BB $15, KT$35, ME$20, CA$30; 68008-BB $20, KT$60, ME$20; 8097-BB $25, KT$75, ME$25, BE$25, CA$30; 80C196 BB $25, KT$100, ME$25, BE$25, CA$30; 80C535 BB$20, ME$20,CA$30. Shipping $5, or air $10. Catalog $4. Check or M.O. to: Kits Plus, 2346 Brandon Road, Dept. CC, Columbus, OH 43221.

ASSEMBLY LANGUAGE BASICS - 64 page beginners guide containing detailed instructions on programming the 8051. Includes I/O techniques, Initialization/RS232 codes and **MORE.** Only $18.00 (360K floppy included) Suncoast Technologies, P.O. Box 5835CC, Spring Hill, FL 34606.

ELECTRONICS

CNC, Build a low cost CNC drill machine for under $295. Uses readily available hardware/software. Plans with instructions, drawings, parts lists and sources $21 + $4.50 S/H US. Send Check or Money orders to **CAMTRONICS INC. 18230 130TH PL NE,** Bothell, WA 98011-3118.

CABLE TEST CHIPS, SA8550, SA8500-310, 311, 320, 321, (specify)-$38.95. 8580/338, 8570xxx, 8590xxx, 8590 (11 BUTTON)-$69.95. TOCOM 5503/07 VIP-$33.95. ZENITH ZF1-$33.95. STARCOM 6 (except BB)-$33.95. STARCOM 7 (except M1)-$49.95. CABLE HACKERS BIBLE(s) VOL. 1. - $44.45, VOL. 2. - $44.95.CELLULAR HACKERS BIBLE-$53.95. CELLULAR CLONING VIDEO-$39.95. CELLULAR PROGRAMMERS BIBLE - $84.45 Catalog - $3.00 Visa/Mastercard (24-HOURS), 602-782-2316 / FAX 602-343-2141 **TELE-CODE** P.O. BOX 6426-CC, YUMA, AZ 85366-6426.

T.V. NOTCH FILTERS AND BULLET STOPPER, FREE BROCHURE. MICRO THinc. BOX 63/6025, MARGATE, FL. 33063 1-(305)-752-9202

FASCINATING kits! Lasers, voice changers, gas sensors, and more! Send $1.00 for catalog. LNS TECHNOLOGIES, 20993 Foothill Blvd. Suite 307R, Hayward, CA 94541-1511.

SOFTWARE

ELECTRONIC CIRCUITS ON COMPUTER DISK. HUNDREDS AVAILABLE. SEND $1.00 FOR CATALOG. M.C. CONSULTANTS, P.O. BOX 11363, LYNCHBURG, VA. 24501.

CLASSIFIED ADVERTISING ORDER FORM

Mail this form with payment to MicroComputer Journal, Classifed Dept., 76 N. Broadway, Hicksville, NY 11801

Name: _____

Address: _____

City: _____

State: _____

Zip: _____

PRINT EACH WORD SEPARATELY. $1.00 per word, 15 word minimum. Note that P.O. Box numbers* and telephone numbers must be counted as two words each. Circle additional words you wish boldfaced at 25 cents each (initial boldface word is free).

1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16

TOTAL PAYMENT ENCLOSED

(Check or Money Order): $ _____
Payment may also be made by MasterCard or VISA Discover or American Express. For this, please fill in information below.

Credit Card Number

_____

Exp. Date

_____

Print Full Name

_____

Signature

_____

*If a box number is used, please supply your permanent address and telephone number for our records.

IBM CD-ROMs, Upto 86.4% Saving! 650+ Titles! **TECH COMPUWARE-MJ3,** 2309 Aspen, Champaign, IL 61821-6272. FAX#: 1-217-351-6471. * Describe your System Configuration For **FREE** Catalog*

SBC 68HC11 64K RAM/EPROM RS232. Free software. Kit or A&T. Fax/Phone 403-341-5676.

VCR REPAIRMAN VER 1.10 Troubleshoot VCR problems on your PC. Simply select symptom and computer will give probable cause. MSDOS $39 +$5 S.H. CBG 14962 Bear Valley Road, Suite G-132, Victorville, CA 92392.

YOUR PHOTO'S BW/COLOR SCANNED ONTO COMPUTER DISK. 2 PHOTO'S $6.00 SPECIFY 5 1/4 - 3 1/2 DISK. QUANTITY PRICES AVAILABLE UPON REQUEST. M.C. CONSULTANTS, P.O. BOX 11363, LYNCHBURG, VA. 24501,804-847-0411.

VIDEO

HIGH PROFITS/no experience necessary. Computer repair/preventative maintenance, learn at home! Complete training package with videos/books. **Make $90/Hour!** Become a certified computer technician! FREE information. ML Productions, Carbondale, Colorado. Call (303)963-1316 Dept. CC-4.

MISCELLANEOUS

ASIAN LADIES want correspondence for friendship, marriage. SUNSHINE INTERNATIONAL-Dept. TW, Box 5500, Kailua-Kona, Hawaii, 96745. (808)325-7707.

HEATHKIT fans! Remember the fun you had building them and learn about the company's history in stories and pictures. 124 pages. $9.95 ($10.71 in WA). Heath Nostalgia, 4320-196th S.W., Suite B-11, Lynnwood, WA 98036-6754.

Free electroplating catalog, books, videos, kits, chemicals. University Publishing House, Box 1071, Provo, UT 84603.

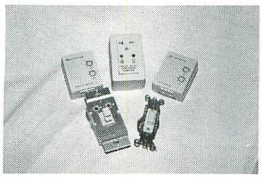
Advertisers' Index

We'd like to see your company listed here too. Contact Margaret Milanese at 516-681-2922 to work out an advertising program tailored to meet your needs.

Home Automation Specials

X-10 Products Plug-In Modules & Wall Switches

Lamp Module *(LM465)*.....$12.49
Appliance Mod. 2-pin *(AM486)*.....$12.49
Appliance Mod. 3-pin *(AM466)*.....$13.49
Heavy Duty 20Amp *(HD245)*.....$19.99
Wall Switch *(WS467)*.....$12.49
3-way Wall Switch *(WS4777)*.....$16.99
Companion Switch *(CS277)*.....$ 6.99



X-10 Mini Controller

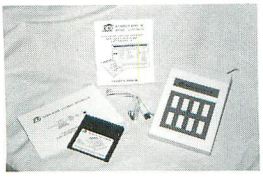
The X-10 Mini Controller turns on/off up to eight X-10 lights & appliances. Selector switch allows control of units 1-4 or 5-8. Features Dim/Brighten, All lights on, All Units Off buttons. *(MC460)*.....$10.99

X-10 Maxi Controller

The Maxi Controller allows for the control of 16 units including Bright/Dim, All Lights On, All Units Off, Group Control. Unit is in an attractive case with smoke color cover. *(SC503)*.....$17.99

Computer Interface

The X-10 Computer Interface is a high power home scheduler. You can schedule up to 256 devices for On/Off, Dim/Bri, Security Time, etc. The Windows version allows for additional control in the 3.X Windows environment. After you set up a schedule, unplug the CP290 from your computer! It will run stand alone. Battery back-up.
DOS *(CP290P)*.....$54.99
MAC *(CP290M)*.....$54.99
Windows *(CP290W)*.....$54.99



FREE CATALOG! *Call and request our 32 pg catalog!*

Signal Problems?

Weak or nonexisting X-10 signals on some circuits can be caused by a lack of signal coupling across the phases in your home. To correct this, simply use our signal bridge. This tuned circuit provides for maximum signal coupling. The circuit is tuned to 120khz for optimum signal transfer. *(6299)*.....$38.99

Plug-In Noise Filter

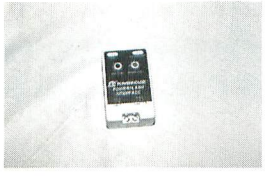
In some installations, it is possible for electrical noise to generate random electrical "noise" through the home. Noise can interfere with X-10 signals. To stop this, plug the offending appliance into the 6288, filtering out the stray noise.
Rated for 5amp. *(6288)*.....$26.99

Universal Module

The UM506 allows for the interfacing of X-10 signals to other devices. The module has a relay that can close momentary or continuous, and a beeper. Use this to open the garage door, drapes, turn on speakers, or control the thermostat. A great device for many applications! *(UM506)*.....$19.99

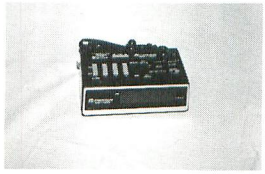
PowerFlash Interface

The PowerFlash Interface is used to allow non-X-10 signals to be sent via X-10. This happens when using the PF284 as an input to your system. The unit has 3 modes of operation, and allows for interfacing dry contact closures and low voltage signals. *(PF284)*.....$22.99



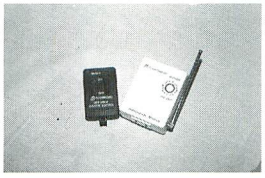
Mini Timer

The X-10 Mini Timer is the first step in automatic control of your home. It's a Mini Controller and alarm clock all in one. It is programmable to allow up to two on and off times per day for each of four module addresses. It has a security mode to vary on/off times when programmed to do so. Battery backup. *(MT522)*.....$18.99



RF Transmitters

The RC6500 Key Chain Remote and RC5000 Wireless Remote send signals via RF to control X-10 components. The RC6500 Key Chain will control 2 devices off/on, while the RC5000 will control up to 16 devices. The units can be used up to 100' away from transceiver (included). The remotes are interchangeable and available separately.
Key Chain System *(RC6500)*.....$26.99
Hand Held System *(RC5000)*.....$41.99
Extra Key Chain *(KC674)*.....$17.99
Extra Hand Held *(RT504)*.....$16.99



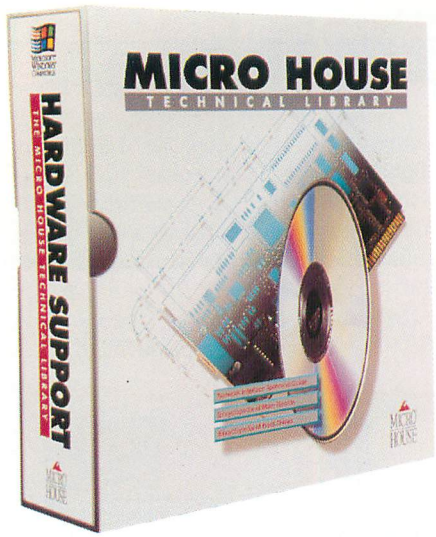
AND MORE...

Listed here are just a sample of the many products available from Hybrid Technical Systems, Inc. We are a company focused on residential and commercial automation. We carry a full line of 120, 208, 240, 277 & 480 Volt AC control devices. Our technical staff stands ready to help you on your most challenging automation needs. We are designers, manufacturers and distributors of the finest home automation products. Call us with your order, catalog request or questions! Our exclusive ***HT-Express*** *delivery guarantees the fastest delivery available!*

ORDERS 24hr **1-800-289-2001**
Fax Orders 24hr 1-803-767-5205
Questions 8-5 EST 1-803-552-2000

No Minimum Orders! We Accept MasterCard & Visa. All orders processed and shipped same day if received by 3pm EST. We ship to all 50 States and Canada. Our Standard Shipping is 2nd day via ***HT-EXPRESS.***

Hybrid Technical Systems, Inc.
4756 Franchise Street
Charleston, SC 29418



The Micro House Technical Library on CD-ROM contains complete configurations, diagrams, settings, component locations, and vital information on 1500 main boards, more than 700 network interface cards, and 1000 hard drive models. It also contains specifications for an additional 1100 hard drives.

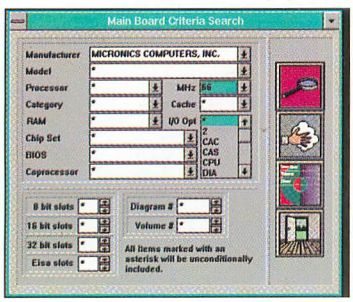
The library contains a full array of specifications from major manufacturers to clone manufacturers including outdated, no longer supported models.

For more details or to immediately start saving valuable support time, call us at **800-926-8299**.

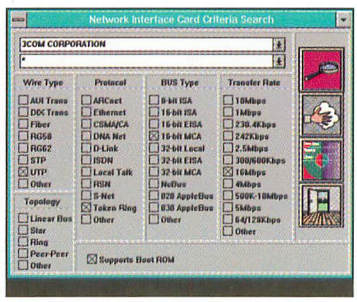
C D - R O M

Hardware Support at Your Fingertips.

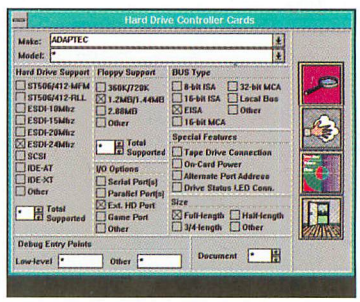
MAIN BOARDS



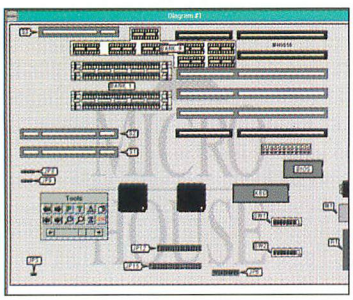
NETWORK INTERFACE CARDS

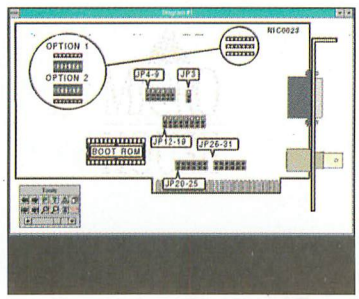


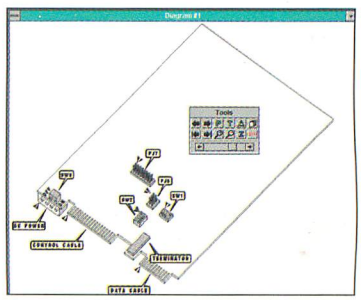
HARD DRIVES & CONTROLLERS



Quick and easy document retrieval through Microsoft® Windows™.







MICRO HOUSE

Micro House International 4900 Pearl East Circle, Suite 101 Boulder, Colorado 80301 vox (800) 926-8299 (303) 443-3388 fax (303) 443-3323

CIRCLE NO. 72 ON FREE INFORMATION CARD